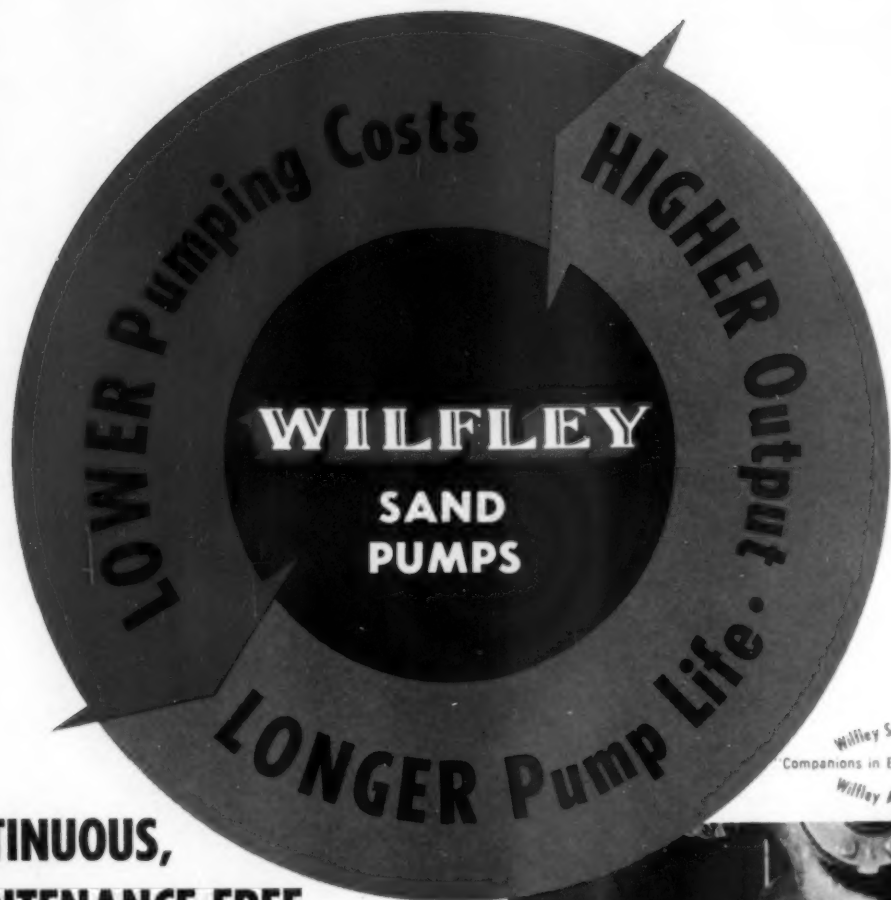


MINING engineering

MAY 1961





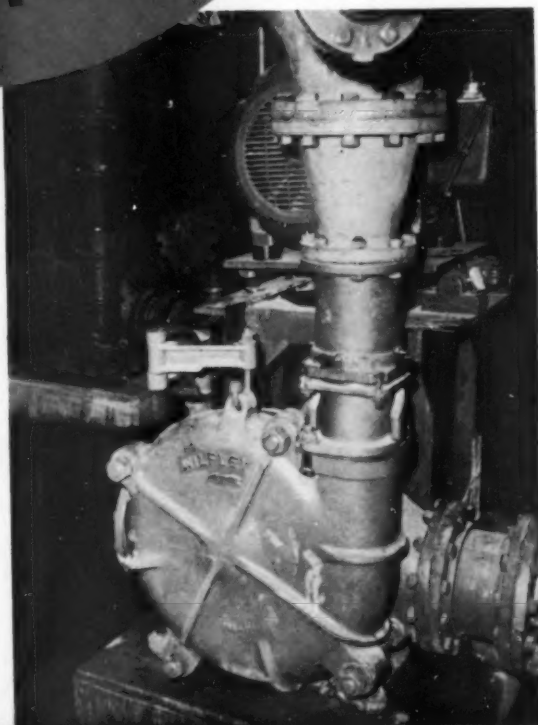
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COMING EVENTS

- May 12-14**, Sixth Annual Uranium Symposium, sponsored by AIME Central New Mexico Section, Grants, N. M.
- May 15-18**, Coal Show of the American Mining Congress, Cleveland. Suggestions for topics to be included in program should be sent to American Mining Congress, Ring Bldg., Washington 6, D. C.
- May 17-19**, First Conference on Management of Materials Research, sponsored by The Metallurgical Society of AIME. Arden House, Harriman, N. Y.
- May 20**, AIME Colorado MBD Subsection annual meeting with technical papers, Broadmoor Hotel, Colorado Springs, Colo.
- May 25-26**, 37th Annual Conference, Lake Superior Mines Safety Council, Hotel Duluth, Duluth, Minn.
- June 2-3**, Spring Meeting of the Central Appalachian Section, AIME, Campbell House, Lexington, Ky.
- June 6-8**, Sixth Annual Appalachian Underground Corrosion Short Course, West Virginia University School of Mines, Morgantown, W. Va. For information write John H. Alm, Publicity Chairman, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.
- June 6-8**, National Coal Assn., 44th Annual Meeting, Mayflower Hotel and Coal Bldg., Washington, D. C.
- June 12-July 21**, Eleventh Annual Short Course in Coal Preparation, West Virginia University School of Mines, Morgantown, W. Va.
- June 18-23**, Summer General Meeting of AIEE, Campus of Cornell University, Ithaca, N. Y.
- June 26**, 64th Annual Meeting of ASTM, Chalfonte-Haddon Hall, Atlantic City, N. J. Bruce Chalmers, AIME, will present the annual Edgar Marburg Lecture in the afternoon.
- June 28-30**, ASME—University of Colorado Joint Automatic Control Conference, University of Colorado, Boulder, Colo.
- July 4-7**, 27th Annual Meeting of The National Society of Professional Engineers, Olympic Hotel, Seattle, Wash.
- July 27-29**, Seventh Annual Institute, Rocky Mountain Mineral Law Foundation, Albuquerque, N. M.
- Aug. 28-Sept. 1**, ASME—University of Colorado International Heat Transfer Conference, University of Colorado, Boulder, Colo.
- Sept. 11-14**, American Mining Congress Metal Mining—Industrial Minerals Convention, Seattle, Wash.
- Sept. 17-20**, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Minerals Beneficiation Division, Brown Palace and Cosmopolitan Hotels, Denver.
- Oct. 2-3**, Joint Meeting, Industrial Minerals Division of SME of AIME—CIM, Ottawa.
- Oct. 5-7**, AIME-ASME Joint Solid Fuels Conference, Birmingham.
- Oct. 18-21**, AAPG Mid-Continent Regional Meeting, Amarillo, Texas.
- Nov. 1-3**, Southwestern Federation of Geological Societies Fourth Annual Meeting, El Paso, Texas.
- Nov. 3-4**, Joint Meeting Central Appalachian Section, AIME and the West Virginia Coal Mining Institute, The Greenbrier, White Sulphur Springs, W. Va.
- Nov. 3**, Pittsburgh Sections of AIME and NOHC Off-the-Record Meeting, Penn-Sheraton Hotel, Pittsburgh.
- Dec. 4**, Annual Meeting Arizona Section of AIME, Pioneer Hotel, Tucson, Ariz.
- Dec. 6-8**, Nineteenth Electric Furnace Conference, sponsored by the Metallurgical Society of AIME. Penn-Sheraton Hotel, Pittsburgh.
- Feb. 18-22, 1962**, AIME Annual Meeting, New York City.
- Apr. 26-28**, AIME Pacific Northwest Metals and Minerals Conference, Ben Franklin Hotel, Seattle, Wash.



VOL. 13 NO. 5

MAY 1961

COVER A common question among prospective strip miners is "How large a machine do we need to remove the overburden? This month a familiar open pit scene, depicted by cover artist Herb McClure, is supplemented by an unfamiliar but rapid method of computing approximate stripping machine size. See the article commencing on page 480.

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- 467** Rock Salt Mining Operations in Michigan, Ohio, and Ontario • W. C. Bleimeister
- 472** Beneficiation of Israeli Phosphate Ore • I. Hoffman and B. C. Mariacher
- 475** Economic Aspects of Interruption of Diamond Production in Congo Republic • A. F. Daily
- 480** Computer Method for Estimating Proper Machinery Mass for Stripping Overburden • H. Rumpfelt
- 488** The Mine Geologist—Past Problems, Present Purpose at Pitch • A. Baker, III, and B. C. Scott

PLUS

- 492** The Story of Atlantic City • W. F. Pruden

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- 516** SME Preprints Available from 1961 Annual Meeting



MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the Drift page.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result

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of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include \$5 in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of \$4.50 per quarter or \$14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., New York 18; 57 Post St., San Francisco; 29 E. Madison St., Chicago 1.

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Superintendent, graduate mining, age 35. Four years experience plant engineer superintendent for industrial mineral producer and manufacturing plant. In charge of design product plants, plant purchasing, cost control, new developments, construction and maintenance heavy and mobile equipment. One year manufacturing of gypsum building products; three years underground gold mining, assistant mine superintendent, mining engineer and shift boss. M-610.

General Manager, Superintendent or Consulting Assignments, B.S. degree in mining, M.S. degree in geology, age 58. Twenty-five years domestic and foreign experience in exploration, development, and operation of open pit, underground, and dredging; construction, transport, heavy equipment, timber; all phases of administration and management. Examination, valuation, and reports. Will locate anywhere. M-603.

Explosive Engineer—Sales, B.S. degree in mining engineering. Experienced in field work, sales, and technical service with explosives and ammonium nitrate. Chemical sales management, coordination with traffic, production, research, advertising departments. Prefer East and Southwest. M-604.

Mine Superintendent or Staff Engineer, A.B. '53, B.S. '56 in mining engineering.

Three years in mine and mill design and engineering; two years in charge of production and bringing new open pit mines into production with necessary haul road construction. Spanish. Prefer East, South, foreign. M-605.

Mine Superintendent-Manager, B.S. degree in mining engineering, metallurgy. Ten years in South American mining; broad background in underground mining, some open pit. Fluent Spanish. Prefer commercial mining, ore buying, or bank examination and/or operations. Prefer South America. M-608.

Mining Engineer, B.S. degree in mining engineering, University of Utah. Summer employment in construction. Will locate anywhere in U.S. M-608.

Raw Materials Engineer, B.S. degree in mining engineering, age 40. Sixteen years production and management experience in mining and mineral processing. Mine plant design, economic studies, geological work included. Extensive report writing. U.S. or foreign location. M-2128-Chicago.

Geologist or Metallurgist, mining geologist, University of Wisconsin '32, age 54. Eight years geologist and metallurgist iron mining, seven years civil engineer in conservation, eight years oil geologist, two years seismograph computer. Will go anywhere. M-2129-Chicago.

POSITIONS OPEN

Mining Superintendent, graduate, with several years underground mining experience and some milling desirable for small mercury mine in Columbia, S.A. Must speak Spanish and accept single status. \$8400 plus board and meals. F174.

Recent Graduate Mining Engineer or Geologist junior position in gold mining, including surveying, some geology, melting and assaying of gold. Some work on gold dredges. Some knowledge of Spanish desirable. \$350 per month base plus 3 months additional salary each year. South America. F136.

Mill Superintendent with experience on pegmatites, to supervise small beryllium ore project. Transportation paid and housing provided. \$8,000 to \$10,000. Brazil. F9980.

Geophysicist for exploration work, to take charge of and be responsible for all geophysical work which will include airborne magnetometer interpretation and conducting and interpreting ground magnetic and possibly gravimetric surveys. Far East. F9987.

Mining Engineer with about 10 years experience, to plan underground development and take care of engineering required in such an endeavor. Open pit mine; however, in near future will go underground. About \$8000. Arkansas. W9605.

Chemical Engineers, graduate, with three to ten years experience in the areas of pilot scale operations and extractive metallurgy. Must be U.S. citizen. Salary open. Employer may negotiate placement fee. Ohio. C8532 b).

Management Consultant, about \$7000 to start, San Francisco headquarters, graduate, young. Recent graduate or with one or two years experience in extractive industry, metallic or nonmetallic. Will assist in industrial research consulting for clients. Knowledge of mine examinations, flow sheets, ore dressing and processing. Also assist in economic studies and marketing investigations. For a national management consultant. SJ-5904.

Geologist, to \$8000, Colorado headquarters, age open. At least five years recent experience in U.S. or western Canada in general exploratory work, including a demonstrated ability to originate exploratory projects, working knowledge of geologic mapping and geophysics and familiarity with geochemistry desirable. Travel about four months of the year in western areas. For a mineral exploration firm. SJ-5926.

Maintenance Superintendent, to \$12,000, in European area, age to 50. Family transport and housing available, three year contract. At least five years recent experience in supervision of repair and maintenance of mining equipment backed up by repair of open pit equipment, foreign experience desirable, able to train local personnel. For a copper and pyrites concentrator and mine. SJ-5931.

Geologist, \$2.85 hr., in Midwest, degree required, age 20 to 35. Experience with core drilling, soils, soils classification, logging, soils lab experience, foundations, calculations. U.S. citizenship required. SJ-6036.

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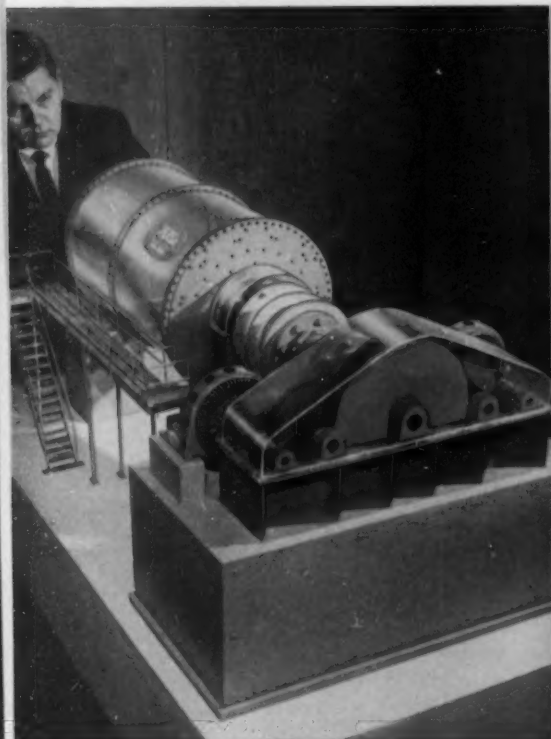
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ideas and news:



Latest step in mill trunnion drive evolution: New TWINDUCER drive divides mill load electrically between twin synchronous motors. Compared to trunnion drives with mechanically divided load, the TWINDUCER drive requires 50% less space. Since there are no floating gears or pinions, gear wear is kept to a minimum. TWINDUCER drive fits any plans for automatic grinding operation.



World's largest crusher to be duplicated: Because it has achieved very favorable results in expanding production and lowering operating costs, this giant Allis-Chalmers crusher will soon have a running mate. Scheduled for installation at the same ore reduction plant is an identical 60-109 SUPERIOR crusher with HYDROSET mechanism. Allis-Chalmers will also furnish two 500-hp motors, four 30-70 SUPERIOR secondary crushers, and four 300-hp motors for the installation. Drive motors and crushers are designed together . . . built together at A-C.

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Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high. You get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of stored energy or solenoid operation.



▼ **Reliable performance that's one mile high:** This A-C substation has completed about five years' service 6546 feet up the remote Wasatch mountains of eastern Utah. Equipment survived rugged transportation up the mountain side on steel skids or trucks over rough bulldozed road. One switchgear fell from truck but was not damaged beyond a few dents. Picked to give dependable performance in this inaccessible, practically un-serviceable location, A-C substation has proved out well beyond expected performance.

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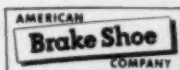
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Mineral Information

An International Directory of Engineering Source Material

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount. Address Irene K. Sharp, AIME Book Dept., 29 W. 39 St., New York 18, N. Y.

It's The Law! by Bernard Tomson, Channel Press, Great Neck, N.Y., 1960, 436 pp., \$7.50—Based on a monthly column written by Judge Tomson over a period of years for *Progressive Architecture*, this book aims to furnish to the architect, engineer, and contractor a basic appreciation of some of the more specific legal questions, contains a special section of standard legal forms, and discusses statutes regulating professional practice, organization and business problems, employment relations, rights and liabilities, and restrictions upon the use of property. There is also a useful index of cases cited throughout the text.

Centrifugal Pumps by Igor Krassik and Roy Carter, F. W. Dodge Corp., 119 W. 40th St., New York 18, N.Y., 1960, 488 pp., \$15.75—This book is a practical guide for all those concerned with the use of centrifugal pumps. In the course of its 27 chapters it discusses how to get maximum service with minimum maintenance and outage, how to best repair or restore every element in the pumping unit, how to select the most efficient, most economical pump for any specific service, how to select the proper controls and driver for any centrifugal pump, and how to select the right materials for constructing any pump for any specific service. A general data section presents valuable information required for engineering pumping installations and for analyzing the performance of existing units. Complex technical explanations and theoretical discussions have been avoided as much as possible in the interest of practicality.

Ultraviolet Guide to Minerals by Sterling Gleason, D. Van Nostrand Co. Inc., 1960, 250 pp., \$6.95—In this book, which is of particular interest to prospectors and hobbyists, the

author describes the uses and techniques of ultraviolet light in the field, laboratory, and mine. Identification charts provide fluorescence and phosphorescence characteristics, physical properties, and distinguishing tests for more than 200 minerals. The book also includes chapters on rare minerals, prospecting, and radioactive minerals. • • •

American Law of Mining edited by The Rocky Mountain Mineral Law Foundation, Matthew Bender & Co. Inc., 205 E. 42nd St., New York 17, N.Y., 1960, 5 vol., \$150.00—This treatise on mining law is the first up-to-date treatment of the subject in nearly half a century. In this period substantial changes have occurred in methods of organization, techniques of mineral development, and in legal matters affecting operational planning and project financing. Modern mining practice presents many intricate questions in technology, multiple use of mineral lands, taxation, securities laws, labor laws, lien laws, radiation hazard regulations, government supports, and techniques of leasing, conveying, financing and operating mineral properties. Volumes 1 and 2 deal with public domain; volumes 3 and 4 with mining operations; and volume 5, taxation forms. • • •

Professional Income of Engineers—1960: Report of Survey by Engineers Joint Council, Engineering Manpower Commission, 29 W. 39th St., New York 18, N.Y., 1961, 51 pp., \$3.00—The fourth of a series of such surveys, this recently released EJC analysis of engineers' salaries in 1960 contains 22 industrial subdivisions totaling 164,657 engineers. It includes separate charts for all industry Ph.D., Sc.D., and M.S. graduates. Also covered are engineering salaries in all levels of federal, state and local government (20,491 engineers) and teachers (more than 5000). The survey includes 1347 engineers in the mining and smelting (nonferrous) industry and 1807 engineers engaged in the ferrous metal industry.

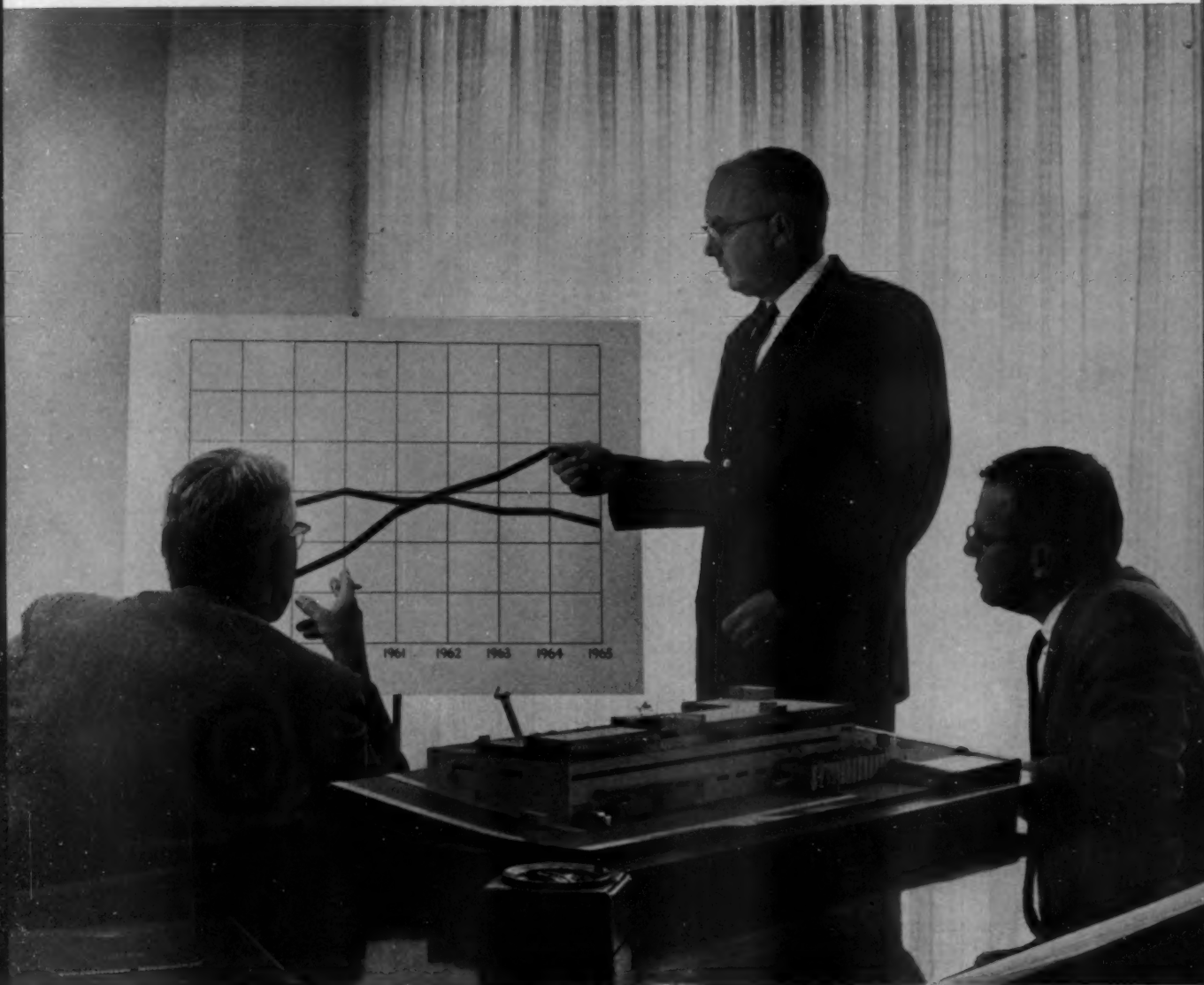
Economic Survey of Minerals in India by A. K. Madan, *Economic & Industrial Publications*, 7 D.B. Gupta Road, New Delhi 5, India, 1959, \$5.00 Plus postage and handling—This volume contains four chapters: Introduction, Growth of the Mining Industry, Survey of Minerals & Mineral Products, and Problems of the Mining Industry. Also included are statistical tables on world production of minerals, a bibliography, and an index.

Quadrilingual Engineering Dictionary by Ten Bosch, W. S. Heinman, *Imported Books*, 400 E. 72nd St., New York 21, N. Y., 1959, 692 pp., \$12.00—The Ten Bosch Quadrilingual Engineering Dictionary will comprise four volumes—a main list of Dutch terms, giving the English, French, and German equivalents, and three supplemental lists, English-Dutch, French-Dutch, and German-Dutch. This first volume, which is the main list, is useful only in translating from Dutch into one of the other four languages, as there is no key list in English, French, or German. There are no definitions included. • • •

The Geology of the USSR by D. V. Nalivkin, *Pergamon Press*, 122 E. 55th St., New York 22, N. Y., 1960, 170 pp., \$15.00—The translator's Preface states that this "may be said to be the first compact and comprehensive account of the geology of the USSR ever published in the Russian language." Its ten chapters deal with the geographical regions of the USSR: Russian Platform, Siberian Platform, West Siberian Lowlands, Ural Mountains, Western Arctic and Timan, Angara Geosyncline, Central Asia, Mediterranean Geosyncline, Northwestern border of the Mediterranean Geosyncline, and Pacific Ocean Geosyncline. Each chapter discusses the relief, stratigraphy, tectonics, magnetism, and economic deposits of each region. A table of geological formation in the USSR and list of magmatogenic and orogenic epochs is included. A supplement contains a two-piece 1:7,500,000 scale geological map of the USSR in full color, compiled by the All-Union Research Geological Institute. • • •

(Continued on page 448)

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ASBESTOS FIBRE STANDARDS

The University of Sherbrooke and the Quebec Asbestos Mining Association have jointly announced the establishment of an Asbestos Fibre Standards Laboratory to be operated within the faculty of Sciences.

The objective of this project is to provide technical and research facilities for the Eastern Township area and to provide impartial fiber testing facilities to assure uniform quality of the many grades made by the nine asbestos producers of the QAMA. The Laboratory will be staffed and operated by the Sherbrooke University, but the technical directions, specifications and procedures, and operating cost will be the sole responsibility of the QAMA.

URANIUM CONTRACT

Western Gold & Uranium, Inc. has signed a contract under which all the uranium ore produced from its Orphan mine at Grand Canyon, Ariz. to the end of 1966 will be sold to Rare Metals Corp. (a subsidiary of El Paso Natural Gas Co.) for processing in its mill at Tuba City, Ariz. The Orphan mine is currently producing at the rate of 7000 tons of uranium ore per month. Under the new agreement, a carbonate leach circuit will be installed at the mill which will result in a saving of more than \$3 per ton of ore milled, compared to the acid extraction process presently being used at the Rare Metals mill.

NEWS

FROM MINE AND MILL

STUDY STEEL POTENTIAL IN NEW ZEALAND

Battelle Memorial Institute has been appointed by the New Zealand government to determine the technical and economic feasibility of establishing an iron and steel industry in that country. The Battelle Institute will work with the government-owned New Zealand Steel Investigating Co. on all phases of iron and steel investigation.

The primary object of the investigation is to determine which steel-making process is best suited to New Zealand's raw materials—especially the country's iron-containing beach sands.

The project, expected to be completed in six months, got underway on April 5 when two Battelle process metallurgy experts arrived in New Zealand. They will obtain the necessary technical and economic information, conduct on-the-spot surveys of the situation, and meet with industry and government officials connected with the project. Upon their

return, they will join other technical and economic specialists to analyze the obtained information and prepare recommendations.

ALASKA COAL FIELD EXPLORED

Exploratory drilling by the U.S. Bureau of Mines in Alaska's Beluga River area (60 miles northwest of Anchorage) indicates that at least 15 million tons of subbituminous coal can be strip-mined there according to an open-file report by the Department of the Interior. However, the Bureau's estimates are based solely upon reserves in a 50-ft thick coal-bed. Discovered during a Bureau reconnaissance in 1957, the Beluga field is potentially of vital concern to Anchorage. Discovery of what appears to be an outcrop of the same seam six miles distant from the drilled area indicates that additional drilling might multiply the estimated reserve many times. A thinner underlying bed could conceivably be even more extensive.



WORLD'S LARGEST DRAGLINE

A walking dragline, reportedly more than double the size of any previously built, has been purchased by Peabody Coal Co. The huge machine, developed by the Marion Power Shovel Co., has a 275-ft boom, an 85-cu yd bucket, and a working weight of over 5100 tons.

The machine's proportions are:

Height from ground to gantry.....	100 ft
Height, pit floor to boom.....	324 ft
Width, shoe to shoe.....	113 ft
Length of house.....	103 ft
Diameter of base.....	80 ft
Total hp (30 motors).....	19,830
Dumping radius.....	248 ft

In specific terms of just what size operation these dimensions enable the machine to perform—it can dig material from 12 stories below ground level, swing it over 550 ft, and dump it on top of a 14-story building.

This mechanical giant, with a lifting capacity of 221½ tons, will require over 2¼ miles of wire rope weighing 82¼ tons. The Marion 8800, which has a swing speed of 1.6 rpm and a cycle time of approximately one minute, will be controlled by one man for both digging and walking operations.



STACKER CONVEYOR AND RECLAIM SYSTEM

The stacker conveyor and reclaim system for primary crusher products shown above are part of the current expansion at the Republic, Mich. iron ore beneficiation plant of the Marquette Iron Mining Co.—a firm jointly owned by Jones & Laughlin Steel Corp., International Harvester Co., Wheeling Steel Corp., and The Cleveland-Cliffs Iron Co. Engineering and construction of this expansion, which will increase capacity from 800,000 to 1,600,000 tons of concentrates per year, is being carried out by The M. W. Kellogg Co.

OFFICE CONSOLIDATION

Spencer Chemical Co. has announced that its plans for diversification and expansion include full use of the mining skills of its subsidiary, The Pittsburg & Midway Coal Mining Co. The offices of Arnold E. Lamm, president of Pittsburg & Midway, and several operating officers of the company will move to Kansas City from Pittsburg, Kansas in the immediate future for integration into Spencer's general offices.

TUBE COOLERS FOR LIGHTWEIGHT AGGREGATES

First application of integral tube coolers in the lightweight aggregate field will be in the Material Service's expanded shale producing facilities at Ottawa, Ill. Scheduled for installation this summer at Material Service, a division of General Dynamics, is an Allis-Chalmers 11-ft, 3-in. by 200-ft kiln with ten 4½-ft diam by 20-ft long Warner tube coolers. The new kiln will be fabricated from an existing 120-ft rotary dryer and a new 80-ft section.

With the addition of this third kiln, the company expects to increase production by over 50 pct of its trademarked product, Materialite. The expanded facilities will make Material Service the largest producer of lightweight aggregate and will help meet the increased demands for its products. The integral tube is expected to increase efficiency and conserve space.



LIGHTER STEEL FOR TRUCKS INCREASES PAYLOAD

Another step in the mining industry's resolve to make Minnesota iron ores more competitive was taken recently when U.S. Steel's Oliver Iron Mining Division specified the use of a new high yield strength steel for truck bodies in an effort to increase the payload of its mine haulage trucks by reducing dead weight. Use of the material, called USS "T-1," will permit trucks to carry more ore in proportion to their over-all weight. Resultant cost savings are expected to assist in improving the cost-quality relationship of Minnesota ore. Use of this steel was specified in a recent order for new trucks, after calculations showed that it would save about 12 pct in weight enabling a would-be 40-ton truck to carry 45 tons of material without overloading.

SALE-LEASEBACK PLAN FOR MINES

A new plan, by which mining companies can sell their existing plant and equipment and immediately lease it back for terms of from 3 to 12 years, has been announced by Nationwide Leasing Co., Chicago. The Sale-Leaseback plan was designed specifically for firms which have an over-large investment in fixed assets and whose growth, as a result, was being hampered by tight capital.

A special feature of the plan is that for selected mining firms it will be possible to sell, for cash, fully or partially depreciated equipment to Nationwide at greater-than-book value and lease it back. A selected firm, in Nationwide's judgment, is one which meets the following conditions: 1) Net worth of the company must be at least three times as much as the sum involved in the sale-leaseback, with a minimum net worth of \$100,000. 2) It must have a history of profitable operations. 3) It must submit an appraisal of the current value of the equipment involved. 4) The company must show evidence of a competent management group.

All types of production and office equipment are included in the plan. Minimum amount considered will be \$25,000; there is no maximum.

GERMANIUM EXPLORATION IN NEW MEXICO

The metallurgical and chemical division of the Susquehanna Corporation is currently engaged in a mineral exploration program near Santa Fe, New Mexico. Initial exploration has indicated the presence of germanium metal as well as copper and uranium. Germanium, used principally as an active element in the manufacture of transistors and semi-conductors, until now has been obtained primarily from the Congo in Africa. The use of germanium has expanded at a rate of 40 pct a year in the past, and prospects for substantial future growth of this mineral seem to be favorable.

AMERICAN AND MEXICAN FIRMS FORM NEW COMPANY

American Metal Climax, Inc. has formed a new company, Metalúrgica Mexicana Peñoles, S.A. Amax brings into the new company the business formerly conducted by its Mexican mining, smelting, and refining subsidiaries. The Mexicans have subscribed to 51 pct of the new company.

The newly formed company will continue the mining, smelting, and

refining operations formerly conducted by the American Metal Climax subsidiary. Expansion plans include a Zinc smelter at Torreón and a sodium sulfate plant at Laguna del Rey where the new company has important mineral claims. The board of Metalúrgica Mexicana Peñoles, S.A. will be equally divided between representatives of American Metal Climax and those of the Mexican group acquiring the 51 pct interest.

MAJOR COMPANY ENTERS NICKEL FIELD

The Hanna Mining Co. has entered a major new field, the commercial production and marketing of nickel. The company has completed acquisition of the smelter that processes ore from the nation's only large nickel deposit, and has begun marketing high grade ferro-nickel for use in the production of stainless and other alloy steels. Through a subsidiary, The Hanna Nickel Smelting Co., Hanna Mining has operated the plant at Riddle, Oregon since it was opened in 1955. To date it has produced more than 100 million lb of nickel, all of which has been for the account of the government to help build the defense materials inventory of the strategic material.

NEWS

FROM MINE AND MILL

ELECTRIC FURNACE FOR PRODUCING SPIEGELEISEN

Construction has begun on The New Jersey Zinc Co.'s Sterling electric furnace project at Palmerton, Pa. which will insure adequate supplies of the iron-manganese alloy, spiegeleisen, to meet demands of the steel and foundry industries.

This new application of electric smelting was developed by the company to treat iron-manganese ores, particularly those from its Sterling mine at Ogdensburg, N. J. The new plant, scheduled for completion by 1962, marks the first commercial installation of this particular smelting system in the U.S. The new installation will be more economical, more efficient, and of wider scope for making various ferrous alloys than are the present blast furnaces which it will replace. These blast furnaces have been used for many years to make spiegeleisen and will continue in operation to provide ample tonnage of the product until the new plant is completed.

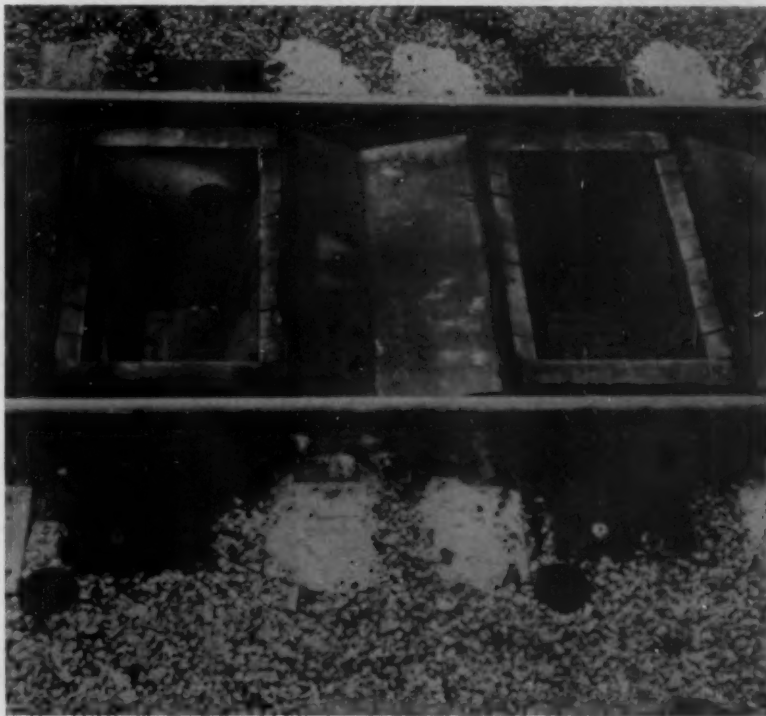
REMOTE CONTROL THAWING STATION

The Baltimore Gas and Electric Co. has completed stockpiling of some 90,000 tons of coal at its new Charles P. Crane station. In spite of an extremely cold winter, the operation was completed on schedule with the aid of a remote control thawing station engineered by Hauck Manufacturing Co. and the Baltimore Gas and Electric Co.

This 225-ft long thawing facility which handles five cars at a time, can thaw up to 10 cars per hour. Thirty-six prefabricated thawing pits are arranged so that any size car, or any combination of sizes in a five-car train, can be thawed effectively without damaging the cars.

Because of the large number of pits and their push-button control, radiant heat can be provided immediately to key areas regardless of the makeup of the train. Determining which pits are to be used for thawing depends on the size of the cars. The operator takes his cue from the lead car which is properly positioned over the pits to establish a point of reference. He then observes the position of the cars along the track and starts those pits that are located under areas to be heated.

The flexibility of this operation not only speeds thawing and saves fuel, but also avoids damage to the hopper cars since any thawing pit beneath a car section which appears vulnerable to damage by heat is not operated.



A closeup of two of the 36 Hauck thawing pits in service at the Charles P. Crane Station. Each pit radiates heat at the rate of 1.5 million Btu per hour. The pits are arranged so that up to 6 million Btu per hour can be made available for thawing a single car. Installing this type of pit requires no underground form work since individual railroad ties are either removed or omitted where the pits are to be located. The hinged covers, folded back in this picture, are closed to protect the pits when not in operation. The thawing station functions from three individually-operated remote control panels.



"PAY DIRT" UNCOVERED AT MISSION

Aerial view at left shows the extent of American Smelting and Refining Co.'s Mission Project near Tucson, Ariz. where some 40,000,000 of an estimated total of 50,000,000 tons of overburden have been removed to date. The pit is now at a depth of 210 ft where copper ore zone is beginning to be uncovered. This ore is being stockpiled for concentration in the mill which is now in its final stages of construction by the Western Knapp Engineering Co.



Work is nearly complete on the 15,000-ton capacity fine ore bin (left photo) at the concentrator. Workmen are installing feeders in buckle-plate steel and concrete storage bins. Ten tons of powder per twenty holes are used in daily blasting operations at the Mission pit (see photo at right). The ore is already being stockpiled in anticipation of the new mill (background, right photo) nearing completion where workmen are installing milling equipment.

The mill site of Asarco's Mission Concentrator is flanked by nearly 40,000,000 tons of overburden already removed from the pit. At the concentrator, a 70-ft mound has been constructed from pit strippings to support two water tanks with a capacity of 600,000 gal. each. A conveyor system connecting the primary crusher, the crushed ore stockpile, the secondary crusher, and mill building is presently being constructed. According to a reliable report, the Mission Project is in its final stages of engineering and construction and is expected to begin full-scale operation in the latter part of this year.



for ECONOMY and PERFORMANCE

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SIZE 50NM41-C

YOU'RE TONS AHEAD WITH AN INGERSOLL-RAND SCRAPER HOIST

Only Ingersoll-Rand gives you barrel-type housing construction to absorb drum loads. Thus the drive shaft and bearings are not subjected to any load strain and perfect alignment of rotating parts is preserved.

☆ **CHOOSE FROM 152 SIZES**

available with air or electric motor drive. Horsepowers range from 5 to 75. Choose from either two or three drum combinations.

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for maximum tonnage on all your loading and transfer applications.

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*Planned Annual Retooling
increases output per man*

REPORT FROM WESTERN MATERIALS INC., PAMPA, TEXAS



"Our new 944 Traxcavator loads and levels nine 18-yd. trucks an hour

It gets its bucket full easier than other machines, is faster and handles better. Has plenty of reach for big trucks, too."

THAT'S the word on the 944 from Craig Childers, Western's Plant Superintendent. And here's what the operator thinks about it, "I like the way it handles. It's really a fast-loading machine; and it has good balance and visibility. The idea of having the lift arms out front where you don't sit between them is great."

You can choose from three sizes in the new Traxcavator line. The 944 packs 105 HP and a 2 cu. yd. standard bucket—the big 966 at 140 HP carries a 2¾ cu. yd. standard bucket—and the 80 HP 922 has a 1¼ yd. bucket. All three mount a variety of buckets and attachments for handling various materials. And all three have what it takes to move more tons per hour and stay on the job month after month with far less maintenance.

Your Caterpillar Dealer has all the facts. Ask him to set up a Traxcavator demonstration on your job, and get a firsthand look at all the new ideas that are built into these machines. It'll be a real eye-opener.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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**TRAXCAVATORS
ARE MAKING OTHER
LOADERS OBSOLETE**

Here's how the 922, 944 and 966 are built to do a better job for you.

CAT DIESEL ENGINES—Turbocharged for efficiency and quick acceleration. Optional gasoline engines for the 922 and 944.

CAT POWER SHIFT TRANSMISSION—gives instant shifting, forward and reverse, 1st and 2nd speeds. High and low range selector also provides two-wheel drive for roading, four-wheel drive for power and traction in work cycles.

OPERATOR SAFETY—Lift arms and cylinders are forward of the operator and cockpit. Visibility is excellent and access is easy... up three wide steps.

LONG REACH—With the lift arms up front, the reach at dumping height of the new Traxcavators is impressive: 57" on the 966, 51" on the 944 and 41" on the 922.

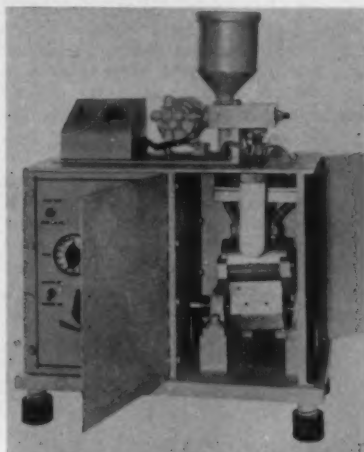
OPERATOR CONVENIENCES—Bucket controls have automatic positioners to speed every cycle; machine controls are all power boosted for easy operation. Dual brakes give operator choice of braking with or without transmission engaged.

FULL LINE OF ATTACHMENTS—Special material buckets, side dump buckets, forks, cabs, etc.

Floor Surfacers

Stonhard Co. has developed a dense, non-porous, self-curing plastic surfacer for protecting floors from most acids, salts, organic compounds and alkalis. This fast-drying material demands no special tools for application. Called "Stonclad," this material can be applied on concrete, wood, metal or brick floors. Circle No. 76.

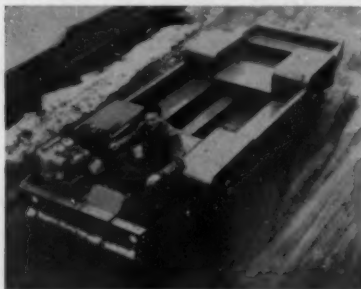
Particle Grinder



Pitchford Scientific Instruments Corp. has developed a particle grinder for spectrographic analyses. This unit employs screens and an air stream to remove particles from the grinding chamber during the grinding operation as well as when the predetermined size is achieved. Sample material in coarse form (up to 3/16-in. diam) is either batch loaded or fed from a mechanical feeder into a cylindrical grinding chamber which is shaken at high speeds. Screens are available as fine as 450 mesh. Circle No. 77.

Personnel Carrier

A vehicle for carrying personnel and/or equipment has been developed by Getman Brothers. Being only 45 in. high, this carrier is especially adaptable for low headroom mines. It is 77 in. wide and 17 ft. 8 in. long with a wheelbase of 98 in. With four wheel drive and four



wheel steering, this vehicle has a maximum speed of 20 mph and a carrying capacity of 5000 lb. It has four wheel hydraulic brakes, 12-v light system, and a high-capacity generator. Circle No. 78.

PRODUCTS

FOR MINE AND MILL

Porta-Screen Accessories

Accessories and equipment for use with their Porta-Screen have been announced by Gilson Screen Co. A feature now available with the Porta-Screen is a provision for a "scalping" operation, when separation of test samples into more than six segments is required. For transporting the testing screens around the laboratory without disassembly, rubber-tired, ball-bearing wheels are available which may be applied to screens now in use, as well as to current production. The same set of wheels may be used on the Gilson Sample Splitter. Circle No. 79.

Rock Drill

A crawler-mounted rock drill with remote controls has been introduced by Joy Mfg. Co. The "TDM-B1" has a flexible swinging boom design, which permits hydraulic positioning of the feed and drill to put down holes in a lateral arc 45° from center. Drilling controls are mounted on an arm that swings with the boom, yet may be adjusted to vary the distance between the drill and the operator. The operator can swing in close to the drill to start a hole, then swing back away from the drill to get away from the rock dust being blown from the hole. Mounted on the feed and geared into the feed mechanism is a reel which keeps the drill hoses aligned and out of the way. As standard equipment, this machine carries a 450-DR rotation drill which has an independent, integral air motor to provide hammerless rotation for coupling and uncoupling drill steel. Circle No. 80.

Centrifugal Pumps

Aurora Pump Division of the N. Y. Air Brake Company has developed a line of close-coupled, end-suction centrifugal pumps which reportedly reduce space requirements and provide easier installation. The effort required for inspection and maintenance is minimized since complete disassembly is possible without disturbing the suction of discharge piping. Vertical centerline discharge makes these pumps self-venting, thus eliminating the possibility of vapor locks and providing smooth running operation with low noise level. The pumps are available in sizes from 3/4x1 in. to 3x3 in., capacities up to 400 gpm, and heads up to 150 ft. Circle No. 81.

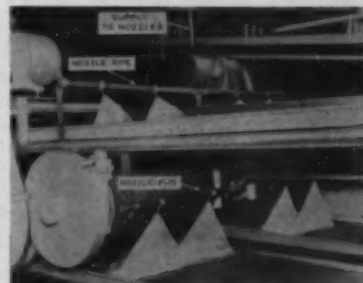
Belting Lacer



An air-operated speed lacer for the high-volume lacing of belting and other materials has been developed by the Clipper Belt Lacer Co. Utilizing a 6-in. air cylinder, this lacer embeds hooks flush with the surface with all strain distributed evenly across the complete joint. Designed for air pressure of at least 80 psi, this machine is available in 8-in. and 12-in. capacity models. Circle No. 82.

Belt Cleaning System

An automatic system for cleaning rubber or steel mesh belts, metal elevators, and elevator belts, has been introduced by Sellers Injector Corp. It reportedly can clean a 200-ft conveyor belt operating at a speed of 20 fpm, in 10 minutes. The system, which operates on plant steam and cold water, has multiple high pressure nozzles spaced at intervals over and under the belt. The nozzles force



jets of hot water and detergent against the belt surface at pressures of 125 to 150 psi. These jets spread at approximately 35 psi producing a cutting action that strips refuse from the belt. Circle No. 83.

PRODUCTS

FOR MINE AND MILL

Laboratory Separator

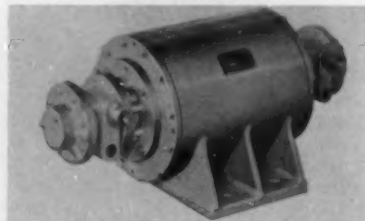
A machine for separating ferromagnetic mixtures has been developed by the S. G. Frantz Co. Designated Model E-1 Isodynamic Separator, this machine supplements but does not overlap in usefulness the Model L-1. This unit operates as follows: The mixture is fed down a covered chute inclined sideways and forward. An alternating magnetic field gives the mixture a certain amount of fluidity and allows it to proceed down the chute. Several times per second the magnetic field is switched off for a few cycles, long enough for the vertical agglomerates to fall to the surface, releasing the non-magnetic particles and allowing them to migrate toward the lower part of the chute. Magnetic particles are



kept towards the higher side of the chute by the non-uniform magnetic field, produced by a several hundred ampere current flowing in spaced rods parallel to the chute. Finally, a chute divider conducts the magnetic fractions to separate receptacles. **Circle No. 84.**

Vibration Inducer

Martin Engineering Co. has developed a vibrator (DVSD-24,000) which reportedly will develop 12 tons of unbalanced force at 3,000 rpm. The "DVSD," equipped with pneumatic or hydraulic drives, has a frequency which may be steplessly controlled from 0 to 3,000 rpm by regulating the flow of air or oil. The unbalanced force is generated by a lead-shot loading which allows simple power adjustments by removing or adding shot to the eccentric weight. Used for the largest chutes and bunkers ever built, the machine must be fastened securely to the heaviest of structural members to be effective. **Circle No. 85.**



Materials Handling System

The Frank J. Madison Co. has developed a materials handling system that uses prestressed concrete channels as the conveyor support. In this design, U-shaped beams are inverted to serve as a protective cover for the belt, drive, idlers, and the material being handled. Inserts for idler attachment are integrally cast in the channels, eliminating the need for steel hangers. Supporting piers and change-overs may be pre-cast or cast-in-place, and no steel structurals are required. Comparative studies for the first installation, a 1½-mile conveyor, indicated savings of 40 pct over conventional steel construction. **Circle No. 86.**

Cable Cutter

A cable tool No. N-2060 for ring cutting the sheathing of "inside type" plastic fabric or rubber covered cable has been made available by P. K. Neuses, Inc. To operate, cable is pushed into tool and against the spring. Back pressure then holds the cable against the cutting blade. An accurate .03125 in. deep cut is made when the tool is rotated around the circumference of the cable. This unit is most practically suited for the customary inside type 3/16 in., 1/4 in., 3/8 in., or 1/2 in., cables, but will handle thin sheathed cable up to 1 in. diam. Cuts are always 1/32 in. deep in each instance. Price: \$7.40. **Circle No. 87.**

Cast Cement Plug

A two-piece cement plug that saves time and expense of preparing tamping bags for large diameter horizontal blast holes has been announced by Austin Powder Co. Called the "ATP" plug, it consists of a cone and base which are loaded as a unit into the hole behind the explosive. To obtain maximum confinement, the solid cone is tamped into the base unit and thus seated solidly in the blast hole. The plug is available in different sizes for holes from 4 to 10 in. diam. **Circle No. 88.**

Vibrating Screens

Syntron Co. has introduced an electro-mechanical vibrating screen equipped with electrically heated screen cloths. Seven models, in single or double decks, are available with screen surfaces of 3x5 ft, 4x6 ft, 4x8 ft, 5x10 ft, 5x12 ft, and 6x14 ft. These screens are especially applicable in the brick and clay industry where there may be moisture content in the clay. The low-voltage secondary transformer provides current for constant, uniform heat, resulting in the exact separation desired and elimination of blinding due to moisture. The unit's motor vibrator has no cams, pulleys, V-belts or other mechanical connections that normally require service or adjustments. **Circle No. 89.**

Air Diffuser Tube

American Brattice Cloth Corp. has introduced a diffuser tuber designed for insertion in a blower tubing line. A cylindrical type diffuser for insertion in a tubing line where miners need additional ventilation permits air to be bled at any point along the line. A reducer type for use near the working face to supply fresh air to workers behind the outlet end of the tubing line provides a venturi action which increases velocity of the air at the discharge end of the tubing. The latter type is used to step down tubing diameter where headroom is limited. **Circle No. 90.**

Engineer's Level

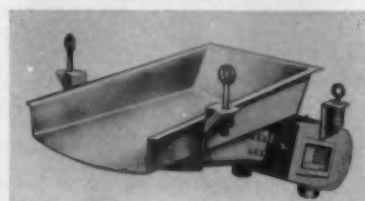
Wild Heerbrugg Instruments, Inc. has designed an engineer's level which includes such features as a 24 or 28-power telescope with coated lenses, internal focusing, clamp and tangent screw, tilting screw with



leverage, and coincidence-reading tubular level. An extra feature of the "Wild N-2" is the telescope which, together with the level vial assembly, can be rotated about the optical axis for checking level adjustments quickly. **Circle No. 91.**

Vibratory Feeder

Syntron Co. has announced the development of a second in a series of vibratory feeders, the Model FH-33. With a maximum capacity of 75 tph, this model meets application requirements between Syntron's Models F-33 (50 tph) and F-44 (100 tph). The 75-ton capacity is based on handling damp sand or coarser materials weighing 100 lb per cu ft in a standard 24 x 42-in. flat pan trough sloped 6° downgrade. Stepless control of feed rate can be adjusted from maximum capacity down to 10 pct of maximum capacity. This model is furnished with separate controller for 115, 230 or 460-v, 60 cycle, single phase, ac operation. **Circle No. 92.**



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PERMIT No. 23801
New York, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

MINING ENGINEERING
P. O. BOX 8073
PHILADELPHIA 1, PA.



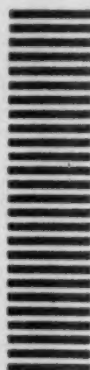
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A NEW FACTOR IN HAULAGE ECONOMICS
FOR MINES OF EVERY SIZE

GREENSBURG DIESEL MINE LOCOMOTIVES



2½ to 25 TONS

Lowest maintenance—easiest operation

Get the facts on this remarkable new line of Greensburg Diesels—rugged, powerful, so easy to run that no skilled operator is required. Only three controls—no gear shifting or clutching—highest quality components—exhaust gas conditioner a feature. Send for literature!

**National Mine
Service Company**



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BEMECO DIVISION
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WESTERN DIVISION
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THE OUTSTANDING MINE VENTILATION LINE

New
complete
catalog
ready
for
you
now



All the data on the complete ABC line. **TUBING:** flexible, wire-reinforced non-collapsible, jute or cotton synthetic rubber coated, Neolon; 2 types of suspension, 2 coupling methods; 9 diameters, 3 lengths. **BRATTICE CLOTH:** 7 types—3 jute, 2 cotton, plastic and Black Ace, and special curtains. **TROLLEY GUARD:** 2 sizes; 2 types. **POWDER BAGS:** 5 sizes; 2 types. Shows methods of hanging and coupling tubing. Includes friction loss charts. Send for your new ABC Catalog today!

**AMERICAN
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330 King's Highway, Warsaw, Indiana
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BOOKS

(Continued from
page 435)

Proceedings of Symposium on Surface Mining Practices, edited and assembled by Harry E. Krumlauf, College of Mines, The University of Arizona, Tucson, Ariz., 1961, 131 pp., \$7.50—This volume is an assemblage of 16 papers presented at the Symposium on Surface Mining Practices held October 17 to 19, 1960, at the University of Arizona. Contents include four papers each on non-metallic mining practices and southwestern mining practices, plus five papers on computers and system analysis. Papers on aerial mapping at Esperanza, materials handling at Ray Mines Div. expanded concentrator, and open pit copper mining are also included. Brief descriptions of these papers are found in *MINING ENGINEERING*, November, 1960. p. 1182. • • •

Three Studies in Minerals Economics, by Orris C. Herfindahl, *Resources for the Future Inc.*, 1775 Massachusetts Ave., N.W., Washington 6, D. C., 1961, 70 pp., \$1.00—These essays, now issued in a single volume, are based on papers given by the author during the summer of 1960 at the Colorado School of Mines as part of the program of the 1960 Western Resources Conference. The first paper, *What is Conservation?* reviews some of the widespread and sometimes conflicting uses of the term and gives the author's interpretation of the basic meaning of conservation for the modern world. It also provides the broad economic and social framework for the two other essays which deal specifically with problems of minerals. *The Long-Run Cost of Minerals* analyzes past trends and inquires briefly into the future outlook for the relative cost of producing mineral products, a problem central to the issue of the adequacy of nonrenewable natural resources to meet the needs of growing populations with rising standards of living. The third essay, *U.S. Trade Policy for Minerals*, is a case study of the lead-zinc industry. It analyzes the record of the past 40 years, the current situation and prospects, and compares some of the possible effects of future policy alternatives.

Electronic Surveying and Mapping by Simo Laurila, *The Ohio State University Press*, 164 W. 19th St., Columbus 10, Ohio, 1960, 294 pp., \$6.00—The author has collected, listed, and analyzed available material on the application of electronics to surveying and mapping, and has added his own experiences as researcher and teacher, first at the Finland Institute of Technology, and later at Ohio State University. He has arranged the book so that it will be usable by geologists unfamiliar

with electronics, and by electrical engineers unfamiliar with geodesy. Part I presents the basic principles of electricity, electronics, electronic surveying and its instruments. In Part II the electronic and magnetic features of various electronic surveying systems are analyzed, emphasizing those functions which primarily effect the accuracy of measurements. In Part III, reductions and corrections of the instrument data are derived so that information obtained from the electronic surveying instruments may be applied to the ellipsoid or the map projection plane. Written as a college textbook, it is nonetheless valuable for anyone interested in the subject. • • •

Extractive Metallurgy of Copper, Nickel, and Cobalt, edited by Paul Queneau with annotated bibliography by Ken G. Robb. This volume is based on an international symposium sponsored by the Extractive Metallurgy Society of AIME held in New York, February 15 to 18, 1960. Approximately 650 pp., the volume contains 24 papers followed by a discussion of each. Some of the papers included under the session headings are: General—Fluid Bed Roasting; Principles and Practice, Chibuluma Cobalt Plant; Fuel-fired Smelting and Converting—Smelting Practices of Phelps Dodge in Arizona; Electric Furnace Smelting—Electric Smelting of Sulfide Ores, Ferro-nickel Smelting in New Caledonia; Atmospheric and Elevated Pressure Leaching—Leaching of Chuquicamata Oxide Ores, Pressure Leaching of Nickeliferous Laterites with Sulfuric Acid; Refining—Industry Report on Modern Copper Tank House Practice; and Bibliography. Orders should be directed to:

The Metallurgical Society
of AIME
29 West 39th Street
New York 18, N.Y.

Price: about \$23.00
AIME Members about \$18.40

History of the Institute—II 1947-1961 by Edward H. Robie, AIME, 29 W. 39th Street, New York 18, N. Y., 1961, 48 pp., \$1.00—This handy little booklet continues the history of the Institute, taking up at the point where A. B. Parsons' *Seventy-five Years of Progress in the Mineral Industry* leaves off. Some of the main topics covered are the reorganization of the Institute into three semiautonomous Societies with its resultant effect on publications; the new building; local sections; medal and award winners, 1948-1961; and presidents of the Institute 1948-1961. A concise guide and reference to the working of the Institute. • • •

STATE PUBLICATIONS

Indiana

Publications Section
Geological Survey
Indiana University
Bloomington, Ind.

Geology and Coal Deposits of the Brazil Quadrangles, Indiana, Bull. 16, 1960, \$2.50 plus 25¢ mailing charge.

Petrography of Indiana Sandstones Collected for High-Silica Evaluation, Bull. 17, 1960, \$1.00 plus 10¢ mailing charge.

Engineering Geology of Dam Site and Spillway Areas for the Monroe Reservoir, Southern Indiana, Progress Report 19, 1960, 80¢ plus 10¢ mailing charge.

Directory of Producers and Consumers of Clay and Shale in Indiana, Directory No. 7, 1960, 35¢ plus 10¢ mailing charge.

Iowa

State Mine Inspector's Office
State Capitol
Des Moines, Iowa

Report of the State Mine Inspector for the Biennial Period Ending December 31, 1960, gratis.

Maine

Maine Geological Survey
State Geologist
Dept. of Economic Development
State House
Augusta, Maine

The Geology of Baxter State Park and Mt. Katahdin, 1960, 58¢.
Maine Mineral Collecting, 1960, gratis.
The Geology of Sebago Lake State Park, 1960, 29¢.

Montana

Montana Bureau of Mines and Geology
Room 203-B, Main Hall
Montana School of Mines
Butte, Mont.

Mines and Mineral Deposits (Except Fuels) Jefferson County, Montana, Bull. 16, 1960, \$1.75.

Progress Report on Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana, 2. Southeastern Lincoln County, Bull. 17, 1960, gratis.

Columbian-Rare-Earth Deposits Southern Ravalli County Montana, Bull. 18, 1960, gratis.

New Mexico

Bureau of Mines and Mineral Resources
Campus Station
Socorro, N. M.

Summary of Pennsylvania Sections in Southwestern New Mexico and Southeastern Arizona, Bull. 66, 1960, \$3.00.

Geology of the Knight Peak Area, Grant County, New Mexico, Bull. 70, 1960, \$1.25.

Mineral Resources of Taos County, New Mexico, Bull. 71, 1960, \$2.50.

North Dakota

Geological Survey
University Station
Grand Forks, N. D.

Stratigraphy of the Winnipeg and Deadwood Formations in North Dakota, Bull. 35, 1960, \$1.75.

Oil Fields in the Burke County Area, North Dakota Geological, Magnetic and Engineering Studies, R.I. 30, 1960, \$2.00.

Summary of the British-American Oil Prod. Co., Julia Van DeErve No. 1, well No. 2600, permit No. 2621, Circ. 231, 1960, gratis.

Summary of the Calvert Exploration Co., D. C. Wood No. 1, Stutsman County, well No. 676, permit No. 684, Circ. 233, 1960, gratis.

Summary of the Calvert Exploration Co., Margaret Meyers No. 1, Stutsman County, well No. 668, permit No. 682, Circ. 233, 1960, gratis.

Summary of the Calvert Exploration Co., F. L. Robertson No. 1-A, Stutsman County, well No. 673, permit No. 687, Circ. 234, 1960, gratis.

(Continued on page 454)



Marcy Scrubbers

PROVED PERFORMANCE on the MESABI IRON RANGE

A prominent mining company in Minnesota is using two 9½'x19½' Marcy Heavy Duty Scrubbers in one of its concentrators, on a tough iron ore cleaning problem. This installation followed use of Marcy Scrubbers in two of the company's other concentrators.

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which results in more effective scrubbing with less horsepower.
- Heavy duty construction, operation on trunnion bearings, and properly designed drives, combine to eliminate vibration.
- With trunnion bearing design there is no maintenance problem due to corrosion and abrasion.

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This Minnesota installation was engineered and serviced through the cooperation of the mining company, Mine and Smelter, and its agent, Continental Sales and Equipment Co., Hibbing.

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SME Announces...

AIME TRANSACTIONS (MINING)

Volume 220, 1961

As Transactions papers are accepted for the forthcoming volume, the titles and abstracts will be published in MINING ENGINEERING. The first list appears below. Watch for additional announcements which will be listed on the "Contents" and SME Bulletin Board pages in future issues.

Anticipated Publication Date: December 1961

61I222 (Geology) Magnetic Taconites of the Eastern Mesabi District, Minnesota by James N. Gundersen and George M. Schwartz.

Utilization of magnetite-bearing taconite from the great Mesabi range of Minnesota is fast becoming a major industry in the state. The planning and early development stages of taconite-processing projects have been described in the literature and an excellent discussion has appeared recently concerning the current mining, crushing, concentrating, and pelletizing techniques of the Reserve Mining Co., whose operations lie entirely within the eastern Mesabi district. The present paper deals with some of the geological aspects of taconite utilization in the district, with emphasis placed upon some of the common mineralogical and textural features of the taconites currently being mined or stripped and how these factors generally affect the potential recovery of the iron from the metamorphosed Biwabik iron formation.

60B72 (Minerals Beneficiation) Recovery of Molybdenum by Liquid-Liquid Extraction from Uranium Mill Circuits by C. J. Lewis and J. E. House.

In the solvent extraction process, also referred to as liquid-liquid extraction, the clarified uranium-pregnant sulfuric acid leach solution is contacted with an organic extractant dispersed in kerosene; the uranium enters the organic phase and associates itself with the organic extractant. Simultaneously, anions or cations, as the case may be, leave the organic extractant phase and enter the aqueous phase. The two phases are then allowed to separate by virtue of their immiscibility.

Based on the data available, a generalized procedure for the recovery of molybdenum from the sodium carbonate scrub liquor of acid leach uranium mills using secondary and tertiary amine extractants is presented, as is another generalized procedure for the recovery of molybdenum from the bleed stream of alkaline leach uranium mill circuits. Such economic appraisal as can be made at this stage of the development is also indicated.

60B5 (Minerals Beneficiation) Size Distribution Shift in Grinding by G. Agar and R. J. Charles.

Experiments on single particles show that the amount of material created during impact that is finer than any chosen size is proportional to the energy of the impact. As the underlying principle of comminution, it might be stated that each unit of energy

input to a given comminution system tends to add to the system an identical assembly of new particles and subtract an equivalent volume of larger particles.

Thus, two of the consequences of the fact that each unit of energy tends to add identical assemblies of new particles to the system are: 1) on continued application of energy, the total charge in any batch comminution system tends to assume the characteristics of this assembly; and 2) the process of comminution may be described by a relationship such as $E = Ak^n$.

60L83 (Geophysics) Model Studies of an Apparatus for Electromagnetic Prospecting by H. E. Swanson.

A description of the field apparatus has been published by D. G. Brubaker. Data from laboratory model studies of the inline and broadside methods of operation are to be presented. The conductor models include a single sheet conductor at several strike and dip angles, and a schistose-type conductor. In addition, data on the effects of the strike length and of the depth of the conductor are presented for the broadside method of operation.

All of the data show that the inclination reverses direction over the top edge of dipping single sheet conductors. Differences between anomalies over conductors dipping between 90° and 30° are subtle, but flat lying sheets can readily be distinguished from steeply dipping sheets. Schistose conductors are easily distinguished from single sheet conductors, and a procedure is given for determining the direction of schistosity. The depth of penetration under ideal conditions is 0.7 of the coil separation.

TN 60B213 (Minerals Beneficiation) Flotation of Cummingtonite by I. Iwasaki, S. R. B. Cooke, and H. S. Choi.

60B103 (Minerals Beneficiation) Fracture and Comminution of Brittle Solids by J. J. Gilvary and B. H. Bergstrom.

The first part of this paper attempts a new approach to energy relationships in fracture and comminution. The purpose of this program of research is to verify or disprove the hypothesis of von Rittinger. The basic method adopted is theoretical. The second part of the paper is concerned with experimental results, described under three headings: single fracture, plural fracture, and comminution.

TN 60B228 (Minerals Beneficiation) Size Distribution Resulting from the

Comminution of Heterogeneous Materials by D. W. Fuerstenau.

60L6 (Geophysics) Relationship of Graphite in Soils to Graphitic Zones by William H. Dennen and Harold Linder.

The graphitic carbon content of soils may be used to detect and delimit subsurface graphitic zones. Spectrographic measurement of carbon in C-horizon soils from several areas in the northeastern United States shows good correlation with known graphitic bodies.

60B102 (Minerals Beneficiation) Energy Aspects of Single Particle Crushing by B. H. Bergstrom, C. L. Sollenberger, and Will Mitchell, Jr.

There are currently several theories of crushing, all of which can be derived from the general energy equation of Gilliland as was pointed out by Mitchell et al. in 1954 and more recently by Rose and Sullivan. If the exponent of the equation $dE \sim dx/x^n$ is assigned values of 2, 1, or 3/2, the equations of Rittinger, Kick, and Bond, respectively, are obtained by integration between suitable limits. Other investigators prefer to let the exponent be a variable parameter.

To help resolve the controversy, the Allis-Chalmers Research Laboratories set up a series of carefully controlled experiments in which the level of energy input required to induce the comminution of a single particle by slow compression loading was very accurately measured. The energy input requirement, in conjunction with the size analysis of the fragments produced at fracture, yielded an accurate energy-product size relationship for the conditions studied.

60H48 (Industrial Minerals) Some Beneficiation Techniques Applicable to Mineral Fillers by Donald R. Irving.

Factors making the development of improved methods for upgrading clays attractive to producers include: depletion of accessible deposits of high-grade clay; rising transportation and labor costs; more exacting specifications; and increased demand resulting from an expanding population and a constantly rising standard of living. Industry recognizes the need for upgrading presently unusable materials and has cooperated with the U.S. Bureau of Mines by providing samples from submarginal deposits and by evaluating the products that the Bureau upgrades. Some examples of recent clay beneficiation work by USBM are given.

NOTE: Copies of papers will NOT be available until after publication.

(101) CAREERS IN THE MINERAL INDUSTRY: "Opportunities Unlimited", a booklet designed to introduce high school and college students to the various careers available in the extractive industry, may now be obtained from the Society of Mining Engineers of AIME. Describing the various aspects of the industry, from exploration to mineral beneficiation, the booklet also discusses such subjects as secondary and college training, selecting a college, the cost of a college education, and the opportunities awaiting a new graduate in mineral engineering.

(102) CABLEWAY MACHINES: Catalog C, published by Sauerma Bros., Inc., illustrates how deep-digging slack-line cableways are used to recover sand and gravel deposits and excavate and haul bulk materials. A table indicates capacities of each size machine at varying haul distances, and components of the slackline are described in detail.

(103) SURFACE MINING CABLES: The *Anaconda Wire and Cable Co.* has released a technical paper (#C-118) covering the development and application of portable cables for surface mining. Information includes cable requirements, maintenance fundamentals, and the repair of damaged cable. It is particularly applicable to the use of electric power shovels in open pit mines.

(104) SINGLE-ROLL CRUSHERS: The Pennsylvania Crusher Division of *Bath Iron Works* has published a 12-page pamphlet describing their Atlas single-rol crushers. These crushers are designed for primary crushing of soft gypsum, shale, slate, coal, fire clay, soft limestone, chemicals, and phosphate rock. The bulletin covers the operation of the Atlas crusher and of the patented overload release that automatically resets the breaker plate for correct product size. Bulletin No. 2025 also includes construction specifications, capacity tables, and detailed dimensions of the crushers.

(105) CLINKER COOLER: *Allis-Chalmers* has released bulletin 22B7869B describing how their air-quenching clinker cooler recuperates more than 75 pct of sensible clinker heat and returns it to a rotary kiln as highly preheated secondary air for more efficient combustion. Features described in the bulletin include an undergrate pulsating damper which permits carrying deeper clinker beds, giving highest possible secondary air temperatures, and extends grate life; and a Nucontroller device which provides continuous control of clinker bed depths.

DATA

(106) BUSINESS OPERATING RATIOS: "14 Important Ratios in 72 Lines of Business", a comprehensive annual study of operating ratios averaged from a wide sampling of retailers, wholesalers, and manufacturers has been published by *Dun & Bradstreet, Inc.* The ratios serve as a yardstick in measuring the performance of one business with others. The ratios reflecting business trends are complemented with text fully detailing their usage and meaning, how they are compiled as well as how they may be interpreted.

(107) HOLDBACK CLUTCHES: Holdback clutches, specially designed to prevent runback or reverse travel of inclined conveyors, bucket elevators, capstans, and related materials-handling or operating equipment, are described in a 12-page catalog released by the *Formsprag Co.* The brochure explains how these sprag-type clutches (with torque capacities from 1200 lb-ft to 136,500 lb-ft) operate, and cites nine of their major design advantages. Supplementary information includes tables and charts covering speed and idler factors, and engineering, dimensional, and mounting data on 12 available models in bore sizes from 1 15/16 to 12 in.

(108) POWER SUPPLY: A power supply handbook and catalog covering dc power design or procurement has been made available by *Dressen-Barnes Electronics Corp.* This 24-page manual includes a step by step procedure designed for engineers who wish to calculate packaging dimensions for multiple dc outputs. Considerations include spacing problems of modular dc power supplies under various conditions of ambient temperature, external cooling, and rated current. The catalog details over 200 power supplies plus 1,000,000 combinations of knitted modules.

(109) CABLE SUSPENSION SYSTEM: An illustrated four-page catalog describing the "Line-Flex" cable suspension system for industrial, processing, and mining applications has been issued by *Perfect-Line Mfg. Corp.* "Line-Flex" sheathing is a modern method of suspending heavy electrical cable without need for special equipment, tools or training. It is reportedly the only cable sheathing able to be placed in tension. Suitable for outdoor catenary or industrial applications, it will not damage cable in installation. This free-air rated sheathing may be bent along its flexible plane using radii much smaller than permitted in equivalent standard conduits.

(110) ELECTRIC MOTORS: Bulletin 2651, published by *The Louis Allis Co.*, outlines an extensive line of electric motors to meet a broad field of application requirements. The bulletin features 23 types of motors with photographs and brief descriptions on applications and available ratings and modifications. The line includes standard squirrel cage motors in ratings from 1/4 hp to 2500 hp along with many modifications such as C or D flanges, P base, and vertical mounting. It also includes gearmotors to 150 hp, dc motors to 150 hp, plus alternators, generators, and associated control.

(111) CRAWLER CRANES: Three technical portfolios covering features and capabilities of their P&H Models 525, 535, and 550 crawler cranes have been made available by *Harnischfeger Corp.* These portfolios include information on the power box design and magnetorque swing system, plus operating specifications of each front end attachment, and detailed descriptions of other mechanical components. There are 52 capacity charts, 13 general dimension drawings, three crane range diagrams, six cutaway photos, and 16 photographs of the units at work.

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(112) **TRUCK CRANE:** A 12-page portfolio covering features and capabilities of the P&H Model 890-TC, reportedly the world's largest truck crane, has been issued by Harnischfeger Corp. The bulletin gives information on the truck crane's magnetorque swing system and complete operation specifications of each front end attachment. The portfolio is also illustrated with capacity charts, dimension drawings, a crane range diagram, and photos of the unit at work.

(113) **PNEUMATIC COMPACTION:** A 15-page folder describing pneumatic compaction has been issued by American-Marietta Co. Bulletin #410 introduces the AMPAC-4, pneumatic compactor which offers a new concept in pneumatic compaction. With sixteen wheels and front wheel drive, this vehicle offers a variable ground contact pressure from 45 to 95 psi. Dry material can be loaded into the water-tight ballast compartment through an 84-in. wide opening, and unloaded through the four large clean-out doors. Drain pipes are provided to empty water ballast, and a low center of gravity provides maximum stability on steep embankments. Wheel oscillation has been designed to equalize ground contact pressures on crowns and grades.

(114) **RECOVERY SYSTEMS:** Buell Engineering Co., Inc. has issued a four-page bulletin describing its complete line of dust collecting, recovery, and classifying equipment. Air pollution, material handling and classification, recovery of material from waste gases, and employee comfort are a few of the broad areas of application for this equipment.

(115) **VIBRATION INDUCERS:** Martin Engineering Co. has issued a 38-page catalog providing engineering data, specifications, and a price list on the Vibrolator line of vibration inducers. It lists 52 sizes and types from the BD-10 to the 3000-lb impact CCVP hopper car shaker. Units are available in five motive powers—pneumatic, electric, gasoline, hydraulic, and steam. The catalog includes an instruction sheet on the CCVP series, illustrating how motors can be replaced in three minutes or changed from air to electric or hydraulic power source. Also shown is a new forced air cooled Motomagnetic electric vibrator of adjustable frequency for use where difficult ambients are a problem.

(116) **MECHANICAL CONVEYORS:** An eight-page catalog dealing with its vibratory mechanical conveyors has been released by Syntron Co. It is fully illustrated and offers complete data, descriptions, and specifications of the company's light, medium, and heavy tonnage mechanical conveyors.

(117) **ROTARY BLOWERS:** A 12-page bulletin by Sutorbilt Crop. describes how a lobe-type, rotary positive displacement blower delivers a metered amount of air against varying pressures with a minimum amount of friction. Bulletin S-32-A describes such design features as the blower's one-piece shaft, anti-friction bearings, timing gears and hubs, and forced-feed lubrication system. Blower operating principles are discussed, and five diagrams and four charts illustrate blower design, dimensions, and performance data for vertical and horizontal models. There is also a discussion of series 3200 gas pumps which are available in vertical or horizontal arrangements.

(118) **CRANE-EXCAVATORS:** The 305 and 405 crawler crane-excavators are the subject of a mailer released by Koehring Co. The folder shows, through ten on-the-job photographs, how these models perform well on pipeline, road, building, and quarry work. Hoe, shovel, clam, dragline, and crane front ends are illustrated.

(119) **BORING UNITS:** Their complete line of earth and rock boring power transmission units and auger sections are illustrated and described in a 12-page brochure released by the Ka-Mo Tools Dept. of Kwik-Mix Co. The brochure covers Ka-Mo's air, hydraulic, electric, and gasoline powered boring units, cutting heads, augers, and feed tracks. Each model in the line is listed along with its condensed specifications.

(120) **HAULING EQUIPMENT:** A 12-page booklet being offered by Athey Products Corp. demonstrates how Forged-Traks operate in laying pipe lines, moving oil drill rigs, and in logging operations. The booklet includes specifications on weight and dimensions and a design chart which provides hauling capacities.

(121) **REMOTE CONTROLLED LOCOMOTIVE:** A 16-page bulletin is available from General Railway Signal Co. which describes and pictures the GRS Locomotive Remote Control System employed on the Quebec, North Shore & Labrador Railway. The GRS system controls the moving and spotting of cars for both loading and dumping of railroad ballast. The system consists of an FM inductive carrier transmitter and a receiver. In addition, integrated controls permit braking, reversing, throttle notching, and car-dumping. Among several other attractions cited, a one-man remote control operating panel can permit selection of two speeds (4 mph or 10 mph) forward or reverse as well as spotting any of five cars to be dumped.

(122) **GRINDING BALLS:** The Colorado Fuel and Iron Corp. has released a folder introducing their alloy grinding balls and their carbon steel grinding balls. The chemical ranges for each size are shown. The smaller carbon steel balls ($\frac{3}{4}$, $\frac{1}{2}$, 1, and $1\frac{1}{4}$ in. diam.) are fully depth hardened (i.e. martensitic structure throughout).

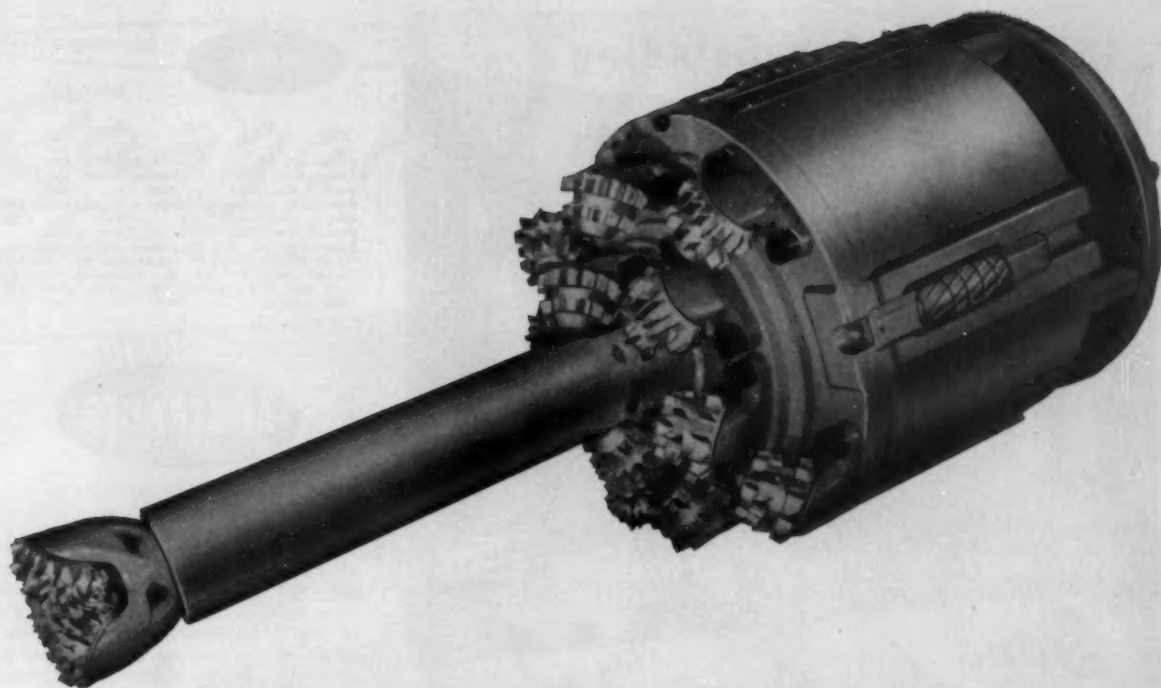
(123) **PHOSPHATE CONTENT DATA SHEET:** A two-page data sheet by Technicon, Inc. outlines a new procedure for continuous, automatic determination of phosphate content of phosphate rock. The reaction is based upon the reduction of phosphomolybdate to molybdenum blue by 1-amino-2-naphthol-4-sulfonic acid after the rock has been sample digested. The procedure reviewed was used for a range of 0 to 25 pct P_2O_5 . Sensitivity increases or decreases may be achieved by a variation in the amount of rock and/or the final dilution of the digested sample prior to analysis.

New Films

The LeTourneau-Westinghouse Co. has produced a full-color, sound motion picture entitled "Dial It." This 12-minute movie illustrates the function of Preco Dial-A-Slope, the automatic blade control attachment for motor graders. The 16 mm film demonstrates the many functional advantages this transistorized unit adds to the capabilities of normal grader operations. To view this film, write or phone your nearest LeTourneau-Westinghouse distributor.

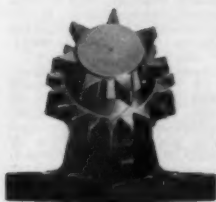
Alaska is the subject of a 16 mm color motion picture available from the U.S. Bureau of Mines library of informational films for free short-term loans for showings throughout the U.S. Sponsored by the Richfield Oil Corp., "Alaska and Its Natural Resources" depicts the State's rich potential in minerals, fuels, fishing, agriculture, timber, and water. The film includes an episode on today's intensive search for more Alaskan oil and natural gas, a search that has drawn more than a score of American petroleum companies to the Kenai Peninsula and other areas. Request for free loans of the film may be sent to: Graphic Services, U.S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.

"It's Your Move," a color motion picture released by the Conveyor Equipment Manufacturers Association, dramatizes the principle of continuous flow in materials handling with a wide variety of examples from bulk handling of coal and gravel to automated processes in manufacturing. Prints of the 24-minute film are available from CEMA. Modern Talking Picture Services, Inc., is handling distribution to television stations, educational institutions, groups in business and industry, and other community organizations.



HUGHES *Shaft Cutters*

put the "bite" in big bits



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for soft formations
(Calcite, shale, clay)



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for medium rock (Limestone,
sandstone, sandy shales)



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for hard rock (Siliceous
limestone, dolomite,
sandstone, granite)



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Formerly type RSC
for extremely hard abrasive
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Shown above is a 44-inch bit which gets its bite from cone type cutters developed and manufactured by Hughes Tool Company. Bits equipped with Hughes cutters are now being used to successfully sink shafts from 2½ feet to 7½ feet in diameter — to depths of several hundred feet. Shafts up to 15 feet in diameter have been drilled on an experimental basis.

Where the rotary method of sinking shafts has been used, results have proved this method of drilling significantly more efficient and economical. Drilling costs are lower, the hole is uniform and clean, and time required is far less than for conventional methods.

Hughes manufactures a complete line of cone-type replaceable cutters, each specifically designed for a particular range of formations. The superior performance built into each Hughes shaft cutter is a direct result of Hughes' more than 50 years of specialized rotary drilling experience.

For more information about the rotary method of drilling large diameter holes, contact your Hughes representative, or Hughes Industrial Products, Hughes Tool Company, Houston, Texas.

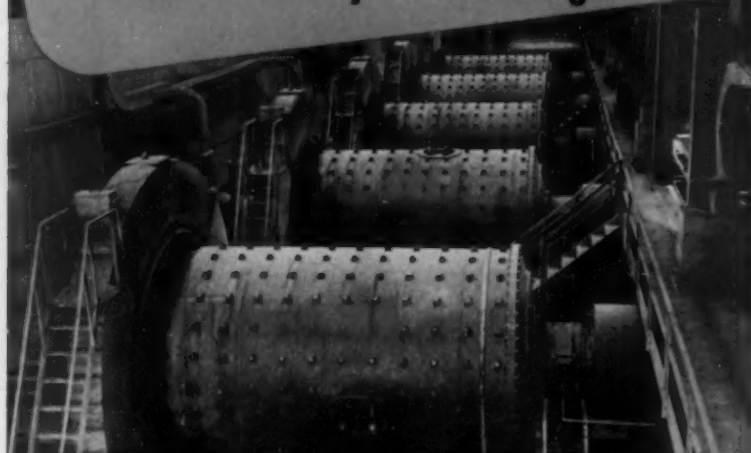
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Calumet Ni-Hard* Grinding Balls

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If you are dry grinding, you will find that Calumet Ni-Hard grinding balls last from five to eight times longer than do alloy steel balls.

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Calumet Ni-Hard grinding balls have established record after record for resistance to abrasion and for lowering grinding ball costs per ton of material ground. One reason is the rigid quality control standards which govern production. Every step in production, from charging the cupola to final dimensional inspection, is thoroughly checked by quality control inspectors.

Microscopic examination of each lot proves that exacting standards of microstructure are met—an important factor in producing a quality product which will give maximum performance in grinding service.

Balls are available from stock in the following sizes: $\frac{5}{8}$ " $\frac{3}{4}$ ", $\frac{7}{8}$ ", 1", $1\frac{1}{4}$ ", $1\frac{1}{2}$ ", and 2". Write for more information.

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BOOKS

(Continued from
page 449)

Summary of the Calvert Drilling Inc., Ray Craig No. 1, Logan County, well No. 1347, permit No. 1359, Circ. 236, 1960, gratis.
Summary of the Arrowhead Exploration Co., Edwin Engstrom No. 1, well No. 2330, permit No. 2342, Circ. 237, 1960, gratis.
Summary of the Cardinal Petroleum Co., Great Plains Royalty, Kaufman, Jr., Ole and Victor Johnson No. 1, Bottineau County, well No. 2272, permit No. 2284, Circ. 238, 1960, gratis.

ABSTRACTS

In This Issue: The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.

Transportation of Minerals in Northern Canada by Amil Dubnie—The present economics of today's modes of transportation in the Canadian North is outlined. Such costs are a major factor in developing the mineral potential of this district. The author briefly analyzes present transportation facilities for water, rail, road, air, and pipeline movement of mineral concentrates. Ref. (MINING ENGINEERING, May 1961) p. 462.

Rock Salt Mine Operations in Michigan, Ohio, and Ontario by W. C. Bleimeister—A review of present-day mining operations in the Eastern Salt Basin, specifically Michigan, Ohio, and Ontario. Methods and equipment are compared in the five major mines of this region—Goderich, Detroit, Ojibway, Fairport, and Cleveland. Ref. (MINING ENGINEERING, May 1961) p. 467.

Beneficiation of Israeli Phosphate Ore by Itzhak Hoffman and Burt C. Mariacher—A brief discussion of the research which lead to a new wet beneficiation process for Israeli phosphate ore of the Negev Desert. The dry beneficiation method employed at the mine prior to the introduction of the wet method is also discussed. Ref. (MINING ENGINEERING, May 1961) p. 472.

Economic Aspects of Interruption of Diamond Production in Congo Republic by A. F. Daily—The author outlines the threat to the industry of the Free World of the loss of the Congo diamond supply for any prolonged period of time. Such a threat is of major importance to the U.S. inasmuch as 46 pct of the U.S.'s crushing bort and 94 pct of the U.S. supply of industrial diamonds are derived from this area. Ref. (MINING ENGINEERING, May 1961) p. 475.

Computer Method for Estimating Proper Machinery Mass for Stripping Overburden by Henry Rasmfelt—The author demonstrates an approach for analyzing overcasting requirements for a stripping project. This approach to the problem employs indicated trends in the relationship of the weight of the machine (only electro-powered draglines are considered) to its ability to do stripping work. Ref. (MINING ENGINEERING, May 1961) p. 480.

The Mine Geologist: Past Problems, Present Purpose at Pitch by Arthur Baker, III and W. C. Scott—The authors depict the role of the mining geologist in the early days of the Pitch mine and of their present use in the operation of the mine. Ref. (MINING ENGINEERING, May 1961) p. 486.

The Story of Atlantic City by W. F. Pruden—The authors present an outline of the proposed flowsheet of The Atlantic City Project presently underway in Wyoming. The mine will be an open pit deposit similar to taconite. The ore will be concentrated and agglomerated in a manner similar to the processes presently underway in the Mesabi Range. Ref. (MINING ENGINEERING, May 1961) p. 492.

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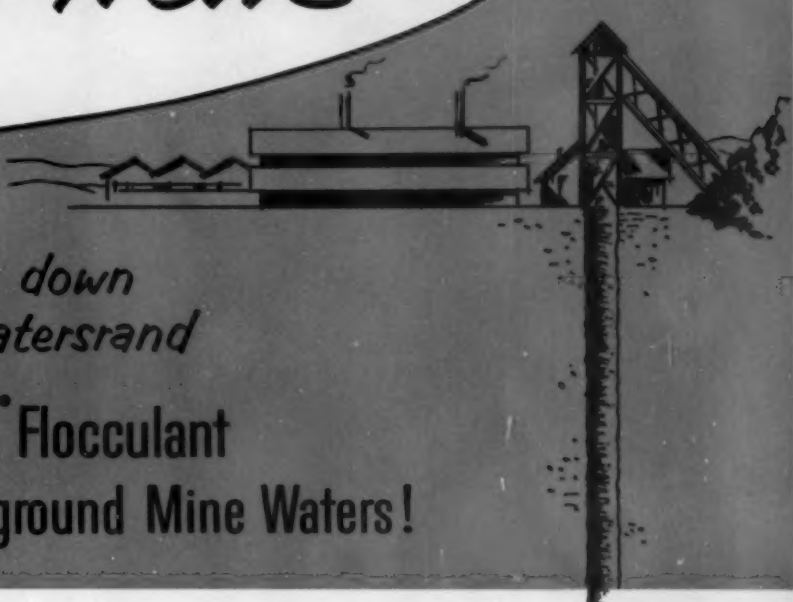
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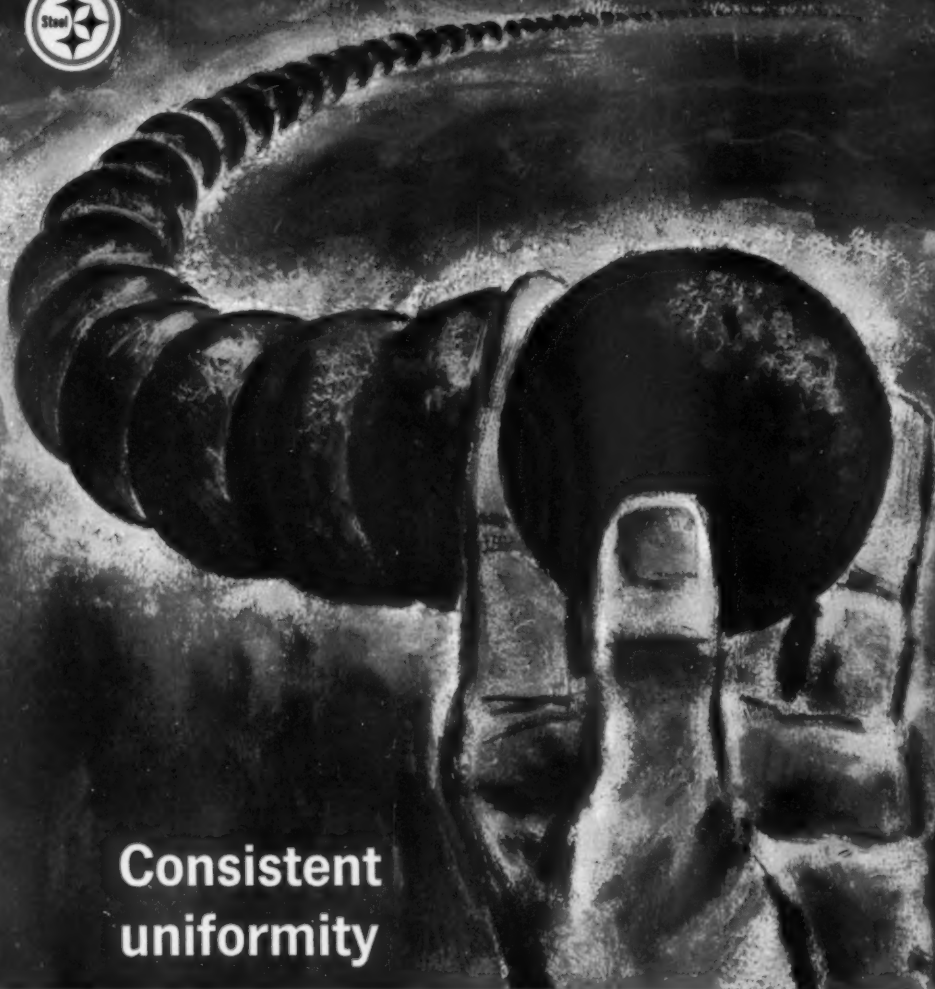
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Cerro Aiming at Rio Blanco Development

Cerro Corp. is now seeking financing for its 120 million-ton Rio Blanco copper deposit northeast of Santiago, Chile. The company said the decision was made to arrange financing following an agreement reached in principle last year with the Chilean government on taxation, repatriation of investment, and other matters. Following acquisition of the needed funds—reportedly some \$95 million—the company will require about five years to bring the property to scheduled initial output of 65,000 tons of copper annually. The ore reserve figures cited are on the basis of present development, and limits of the deposit have not yet been delineated.

Cerro, Newmont Enter Cement Field

Another diversification first was announced by Cerro Corp. which is making its first move outside of the metals field by joining with Newmont Mining Corp. in plans for constructing a \$64-million cement plant about 12 miles south of Albany, N. Y. At present, the cement industry is troubled by excess capacity and is operating at about 74 pct, but the companies said market studies indicated growing demand for the construction material. The proposed plant will use two kilns capable of producing a total of 10 million barrels of cement a year. The planned kilns are believed larger than any now in use in the U. S. The new plant—to be erected on a 2000-acre site with large limestone reserves—will be operated by a company called Atlantic Cement Co., Inc.

Deep Sea Test Drill Reaches Basalt Layer

The upper portion of the *second layer* of the ocean floor was identified for the first time as a fine-grained basalt by CUSS I, the experimental drilling ship of Project Mohole operating in 12,000 ft of water off the west coast of Mexico. The drilling work, which prefaces the ambitious program to penetrate the Mohorovicic Discontinuity, brought up cores of soft, gray-green clay of Miocene age before reaching the basalt at a depth of 560 ft.

Iron Ore Beneficiation Increasing

A record of 52 pct of U. S. iron ore was beneficiated before shipment last year according to a government estimate cited by the American Iron and Steel Institute. Considerable growth of beneficiation is evidenced by the upstep from 1950 when only some 27 pct of domestic ore was treated. There are now more than 90 treatment plants associated with mine facilities in the U. S.

Olin Studying Aluminum Process

Olin Mathieson Chemical Corp. plans an expenditure of more than \$500,000 to verify laboratory work indicating that aluminum can be made from clay or coal shale at a cost comparable with that of processing bauxite to make aluminum. The company made no announcement of its time schedule for commercializing the process.

Huge Drainage Project for Peruvian Mine

Cerro Corp. announced plans for twin drainage tunnels expected to cost \$8.4 million at the Casapalca mine of Cerro de Pasco Corp. The mine, troubled by hot water flooding, is located at an elevation of almost 14,000 ft in the Andes of Peru. Flooding prohibits work below the 930-ft level, but the new project is expected to allow mining to 2400 ft below the existing limit, permitting access to extensive silver, lead, and zinc orebodies. The two tunnels, about 8 ft in diameter and some 30 to 60 ft apart, will be seven miles long and will require about five years to complete. One tunnel will be used for hot water removal, the other will serve ventilation requirements.

Amax Joins Tungsten Mill Financing

Northwest Amax Ltd., Canadian subsidiary of American Metal Climax Inc. will join two other firms in financing a tungsten ore mill to be built on Amax property in the Northwest Territories. The concentrator is being built by Canada Tungsten Mining Corp. Other firms involved in the financing are Ventures Ltd. and Dome Mines Ltd.

Kennecott Increases Copper Output

Kennecott Copper Corp. boosted production at its Western Mining divisions by increasing the work week from six to seven days in a move reflecting the recent upswing in copper demand. The company previously announced it would recall some 200 employees at its Bingham open pit in Utah.

OME Program Results

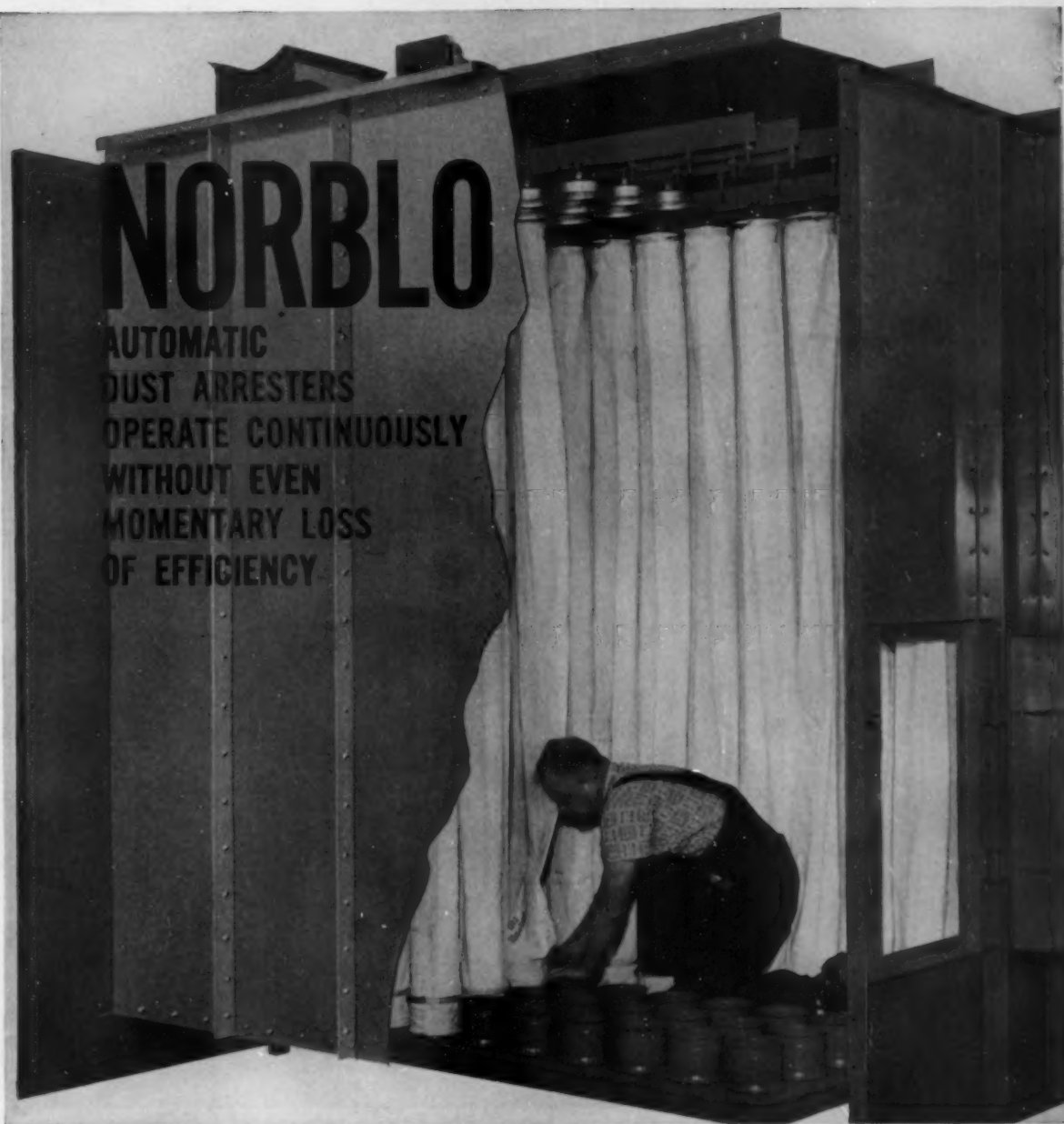
The Office of Minerals Exploration announced its exploration financing assistance has resulted in discovery of ores with net recoverable value of almost \$1 billion. The agency said it presently is providing aid for exploration for more than 30 minerals.

VCA Options Molybdenum Deposit

Vanadium Corp. of America said it would option to American Metal Climax Inc. its Red Mountain molybdenum properties in Colorado. The mine, closed since 1947, was one of the first working molybdenum mines in the U.S. VCA said it expected American Metal Climax would re-evaluate the deposit through a drilling program.

IMC Completes Cast Iron Lined Shaft

International Minerals & Chemical Corp. (Canada) Ltd. has finished installation of a 3000-ton cast iron lining for a shaft at its Esterhazy, Sask., potash deposit. Troublesome ground forced use of freezing techniques that required almost a year to complete. The shaft sinkers cut ground using pavement breakers and descended in 5-ft increments, putting 11 cast iron segments in place with each advance. The shaft runs from the 1130-ft to 1488-ft level.



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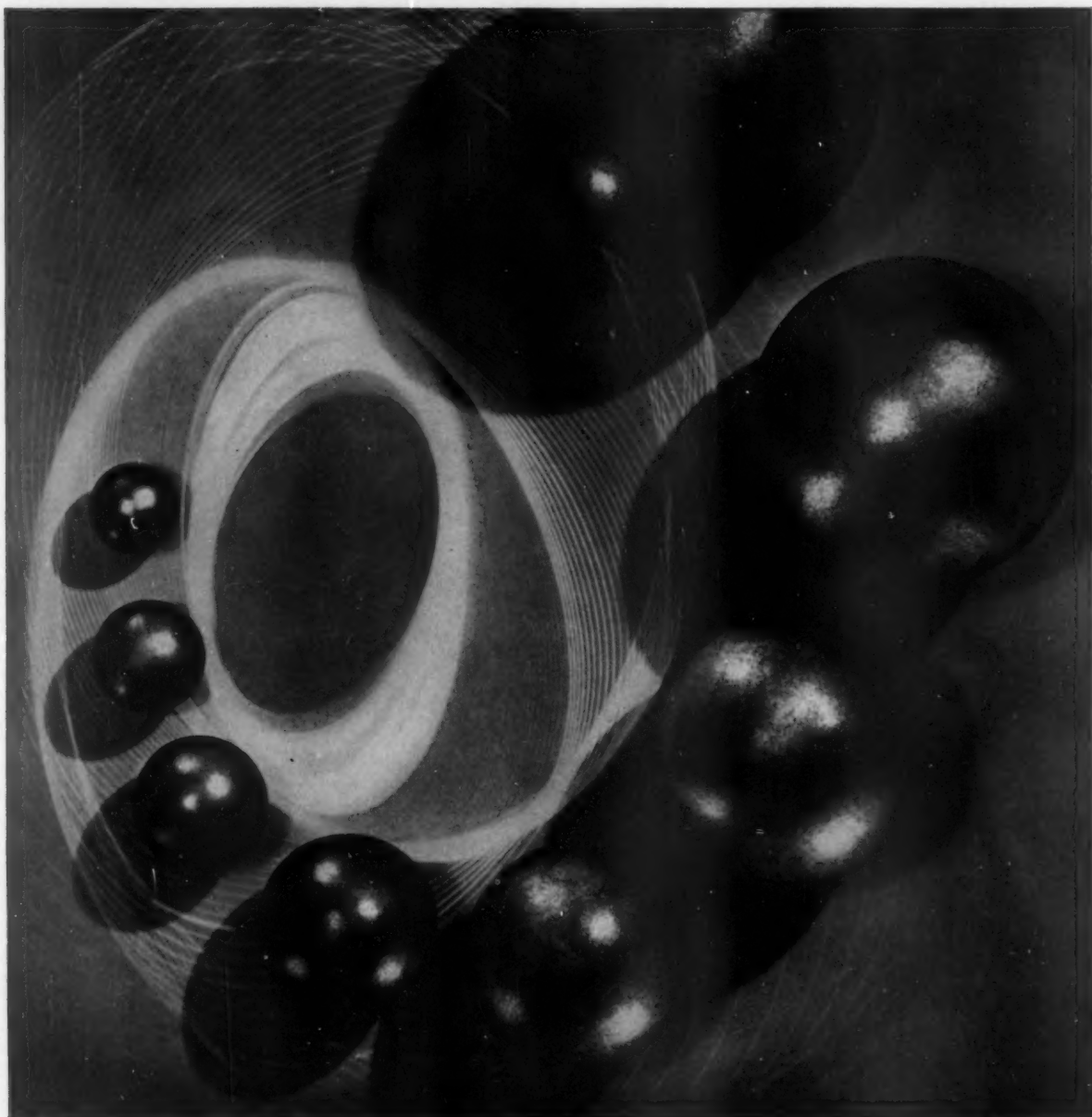
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DRIFT

SALUTE TO A PRESIDENT

"The Many Sides of an Able Man" might be a more suitable title for this section of "Drift." The man to whom we refer is Herbert Hoover who, among several other accomplishments in his career, attained the Presidency of AIME during the year of 1920. On April 27, Mr. Hoover received an award from the exclusive Explorers Club for his activities as a mining engineer during a 16-year period around the turn of the century. The work for which he was honored started in 1897 when Mr. Hoover began exploring a part of Australia, a program which ultimately led to the opening of a gold field. Several years later the Emperor of China commissioned him to search for gold, coal, and oil, as well as other minerals. From 1902 to 1907, Mr. Hoover took five trips around the world and visited many then-unexplored areas. In 1908, he went to Burma where, during the next six years, he opened one of the largest lead, zinc, and silver mines ever discovered.

Although Mr. Hoover's background as a mining engineer is widely known, few people are aware of his exploits during this period of his life. It is with pleasure that we take this opportunity to congratulate Mr. Hoover on this latest honor bestowed upon him—being particularly proud that he earned this award during his early years of membership in AIME.

A KEY SERVICE

To assist members of SME in obtaining additional information on products available to the mineral industry, the editors of MINING ENGINEERING have initiated a new service. Advertisements in the magazine (commencing with the April issue) are now being "keyed" to numbers on the Reader Service Card. Thus, merely by circling on the Reader Service Card the appropriate number found at the bottom of each advertisement and mailing the self-addressed card, the manufacturer will be notified that you wish more information on the particular subject described in the advertisement. For our readers, it is hoped that this system will eliminate the pain and burden of having to write letters for such material.

TRANSACTIONS VOLUME 220—IN THE WORKS!

Now that the 1960 Transactions volume is available to members of SME (see page 518), work has begun on the 1961 volume. This preparation is proceeding smoothly, and the new volume will be available in late 1961. Designated as Volume 220, it will contain approximately the same number of papers as this year's book (over 70) and will be a valuable addition to your technical library. From time to time, a partial contents page containing abstracts of accepted papers will appear in MINING ENGINEERING (see page 450 of this issue for the first such list). This listing will, of course, be kept up-to-date as new papers are accepted for Transactions volume, allowing you to have titles and abstracts of all transactions articles prior to publication of the book.

TRANSPORTATION OF MINERALS

IN

NORTHERN CANADA

by AMIL DUBNIE

Three periods of major activity have led to the development of the present mineral industry in northern Canada. At the turn of the century, placer gold was discovered in the Yukon Territory and production has been continued to the present day. In the late 1920's and early 1930's, vigorous aircraft-aided exploration resulted in the discovery and production of radium at Port Radium on the southern shore of Great Bear Lake and of gold at Yellowknife on the north shore of Great Slave Lake. During this period, oil was discovered at Norman Wells.

Present mineral production is today largely derived from deposits which have been developed in the 1950's. Among these are the re-opened deposits of United Keno Hill, uranium deposits at Uranium City, natural gas resources from the Peace River gas area, nickel-copper deposits at Lynn Lake and Rankin Inlet, and the Cassiar Asbestos deposits at McDame Mountain.

In Yukon and Northwest Territories, five underground mines and one major dredging operation account for practically all of the metal production. The Norman Wells field is the only petroleum and natural gas producer. Annual mineral production from the two territories currently amounts to about \$40 million, approximately 2 pct of the Canadian total. Mineral production north of latitude 55°N, the region discussed in this paper, amounted to about \$133 million in 1959 or approximately 6 pct of the Canadian total, but this total will increase substantially due to the recent commencement of operations at the Thompson nickel mine and smelter in northern Manitoba.

Despite this relatively small mineral production, its present and potential value completely overshadows that from other northern industries. In Yukon and Northwest Territories, the value of the fish catch amounts to about \$1.5 million a year and the fur catch to about \$1 million. Sales of forest products are dependent chiefly on activity in the mineral industry. In the future, it is possible that trapping will decline, fishing will increase slightly before leveling off, and the forest industry will increase as mining operations provide expanding markets. These projections are not intended to minimize in any way the importance of these industries, but

it is clear that the future of the north and its people rests primarily on the development of the mineral resources.

Until the present, there has been no particular need to develop the mineral resources of the north, and even today there is an apparent surplus of many mineral commodities. However, conservative predictions about long-term requirements lead to the conclusion that serious steps must be taken now to maintain reserves against expanded future requirements. A logical possible source of future mineral supplies is the vast, largely unexplored, northern region of Canada. However, such exploitation and rate of development are necessarily related to cost factors of such work, not the least of which is the cost of transporting mineral concentrates from the Canadian North to distant processing plants.

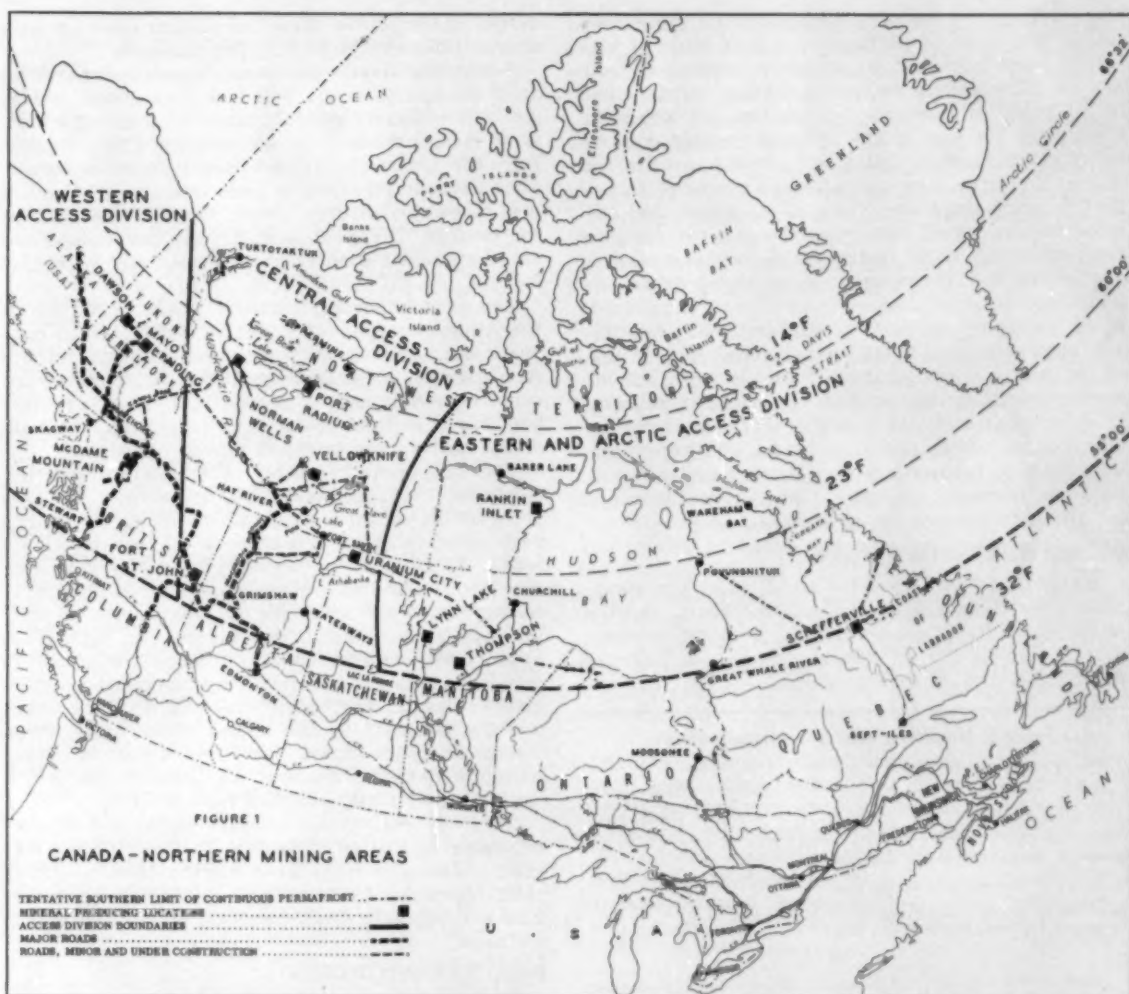
The Canadian North, for purposes of this paper, includes all Canadian territory north of latitude 55°N. This area covers the northern parts of seven Canadian provinces and approximately 1,500,000 sq miles of territory under federal jurisdiction. All territory north of latitude 60°N is under federal jurisdiction except for relatively small areas of Quebec and Newfoundland.

ENVIRONMENTAL FACTORS

Terrain presents problems in overland transportation independent of distance. Most of the north is covered with muskeg which adds tremendously to costs of sub-grade construction. In addition, the exact nature and extent of Canadian muskeg areas has not been determined although significant progress has been made on basic research problems concerned with properties and classification of organic terrain by study of air photographs. The work of the National Research Council provides a firm base for advancement in methods of muskeg control. However, costs of road construction will remain high owing to the costly construction techniques required.

Despite the muskeg, roads and railways are built where transportation economics justify construction. Materials are transported by mining and oil exploration companies over muskeg-covered areas year-round. Transportation over muskeg is aided by freezing conditions which create a firm, reasonably level surface, but early in winter, snow-covered

A. DUBNIE, is Senior Mineral Technologist of the Mineral Resources Division, Dept. of Mines and Technical Surveys, Ottawa, Canada.



R.A.

MINERAL RESOURCES DIVISION, DEPT. OF MINES AND TECHNICAL SURVEYS.

muskeg creates a hazardous travel condition, especially if the temperature has been unusually high.

Permafrost, a permanently frozen state of the near-surface soil independent of the nature of the material composing that surface, increases in depth as one moves north. Permafrost is often an aid to road construction and cross-country transportation, but where large quantities of materials such as gravel must be obtained, permafrost is a hindrance. Supplies of fill for mining or of gravel for construction are difficult to obtain owing to the relatively thin layers of material which can be scraped off between periods of thawing. Winter supplies of aggregate would be very difficult to obtain. An unfavourable feature of permafrost which affects road and other construction is the relatively poor drainage of the surface, caused by the underlying frozen portion. When the shallow thawed portion, (known as the *active layer*) is broken by tracked vehicles crossing muskeg terrain in summer, an impassable water-logged surface soon results. Permafrost is not a serious obstacle to underground mining except for the difficulty of obtaining gravel fill.

MODES OF TRANSPORTATION

Transportation cost is the greatest single deterrent to development of northern mineral resources. It affects exploration costs by increasing the capital

required to maintain parties in the field; it affects production costs by raising the cost of incoming material and reducing the net return on final products; and it raises living costs for all personnel in the area. Higher cost of living eventually affects the cost of exploration and production. It is of interest to note that, with few exceptions, present producing mines north of latitude 55°N are so located that they are able to transport a considerable portion of their shipping requirements by water. Reliance on relatively low seasonal water transport costs as compared to air or overland transport, has not, however, solved the problem of large supply inventory requirements to carry operations over the long winters. Cost experience of existing mineral concentrate movements indicates the following range for the various transportation methods:

Transport	Cents/Ton-Mile	Approximate Weighted Average, 1955, Cents/Ton-Mile
Rail	0.83 to 9.1	0.87
Inland Water	6.0 to 12.0	8.0
Northern Coastal	0.8 to 2.5	
Road	5.0 to 25.0	
Air (non-charter)	40.0 and up	

There is little need to discuss at length these five major modes of transportation which can be applied to movement of mineral products. These are

characterized by varying capital-to-operating cost ratios. The relative position on a cost basis of rail versus road transport in southern regions is well known. However, as extensive railway construction in all types of northern terrain has not yet been attempted, there is scope for considerable controversy concerning the relative positions in terms of capital and operating cost of these modes of transport in northern areas. There is no doubt that the same factors which determine the relative position (cost-wise) of water transport in southern regions also come into prominence in northern areas but additional seasonal factors must also be considered. In air transport, seasonal factors are not so important; operating costs are, however, much higher than in the south as higher cost of fuel in northern locations affects airline tariffs to a greater extent than those of other forms of transport. Pipelines are least affected by higher operating costs, but experience with them in the north is very limited and the comparative increases in capital costs over southern installations are not yet defined.

WATER TRANSPORTATION

Water transport serves the areas which are accessible from Hudson Bay, the Atlantic coast, and the Arctic coast. Rates are reasonable, but arrangements must be made far in advance to ensure delivery during the short shipping season.

Table I. Northern Water Transport Rates

Route	Approximate Rate, \$/Ton	Approximate Distance, Statute Miles
Montreal to Rankin Inlet, 900 tons minimum	41.50	2,900
Montreal to Great Whale River, general freight	75.00	2,900
Montreal to Arctic coasts (Dew Line)	200.00	—
Moosonee to Great Whale River, general freight	25.00	350

Sources: North Rankin Nickel Mines Ltd., and Canadian Government Publications.

Hudson Bay is free of ice about July 15 and shipping is possible until at least mid-October. However, the length of time during which ocean-going ships are covered by insurance is about only 2½ months. In addition to shipping from St. Lawrence River ports and from overseas, barges and other craft are available from Moosonee, Ontario, and Churchill, Manitoba for transportation within Hudson Bay.

The Hudson Bay Co., operating out of Montreal as a common carrier, provides one service trip a year to trading posts in the Arctic and sub-arctic when mail is delivered and heavy supplies are replenished. The supply ship, *M. V. Rupertsland*, can navigate as far inland as Baker Lake. The one mining company at Rankin Inlet in the Northwest Territories moves considerable freight to and from Rankin Inlet during the short shipping season. Examples of 1959 rates on these routes are listed in Table I.

The Pacific coast is an important means of access to northern British Columbia and Yukon. Owing to adequate depth of coastal waterways; to the existence of numerous deep inlets; and to the ice-free nature of the routes, shipping in this area has long been an important aid to development of the northwest. Rates for water shipment along coastal routes are comparable to coastal rates elsewhere. Esti-

mates by the writer place the coastal rates on bulk concentrates at 0.8¢ to 2.5¢ per ton-mile.

Navigable rivers are more numerous north of 55°N than is generally believed. One serious obstacle is the climate which results in freezing conditions lasting more than six months. From Hudson Bay, the Chesterfield Inlet-Baker Lake waterway allows coastal steamers to penetrate about 160 miles into Keewatin district. Other large rivers such as the George, Churchill, and Hayes allow inland access for about 200 miles from Hudson and Wakeham Bays.

The most important northern inland waterway is the Athabasca-Slave-MacKenzie system which connects the railhead at Waterways, Alberta, to the Arctic ocean. Although part of this route serves the same terminals as a highway, and the river route contains a 16-mile obstacle to navigation, the bulk of the northbound traffic is moved by barge.

The transportation rates of the largest carrier, Northern Transportation Ltd., are maintained at a level which shows a moderate profit on operations each year. A good estimate of the ton-mile rate would be from 6¢ to 12¢ on general freight, with the lower rate more general on long hauls. Commodity rates are available for movement of bulk products such as sulfur, petroleum, and logs. If an appreciable volume of southbound freight were generated, the rates could likely be reduced appreciably. Distant Early Warning (DEW) Line bases are also supplied by the inland water route. From the mouth of the MacKenzie River, a fleet of barges maintained there, services all installations which can be conveniently supplied from the base.

Only one regular southbound movement of concentrates by water is known in the Hudson Bay area, a 300-mile haul from Rankin Inlet to Churchill, Manitoba. Cost on this seasonal haul is about 2.5¢ per ton-mile, bulk handling at both terminals included.

RAIL TRANSPORTATION

Insofar as bulk movement of minerals is concerned, the importance of the railways overshadows other forms of transport. In northern Quebec, the 360-mile Quebec North Shore and Labrador Railway has quickly risen to first position among the northern carriers as a volume carrier of mineral products. In the central portion of Canada, mining operations and the port of Churchill are served by the Hudson Bay Railway which is owned by the Canadian Government and operated by the Canadian National Railways. Traffic on this railway has increased in recent years and mining developments of The International Nickel Co. of Canada Ltd. at Thompson, Manitoba, will no doubt contribute considerable freight revenue. In Alberta, the Northern Alberta Railways is an important link in the northern supply route. On the west coast, the Pacific Great Eastern Railway and the White Pass and Yukon Railway are the only railroads available for movement of northern freight. The White Pass and Yukon Railway is a vital link in the transportation of mineral concentrates.

Cost experience of the railways listed in Table II. indicates that rates can be comparable to those prevailing on the major east-west railways provided economies of scale can be realized. The "ton-mile" costs for representative shipments are listed below. The listing applies to commodity tariffs in effect during May 1960. Rates on other northern railways are not shown because these railways do

Table II. Some Canadian Railways Rates

	Cents/Ton-Mile
Quebec North Shore and Labrador Railway (iron ore)	0.83
Hudson Bay Railway (copper-nickel concentrate)	1.37
White Pass and Yukon Railway (lead-zinc concentrate)	9.1

Source: Compiled from tariffs filed with The Board of Transport Commissioners for Canada. Concentrates of lead, zinc, and asbestos, which are currently produced near Whitehorse, move under a combined railwater rate from Whitehorse to Vancouver. Handling included, cost for lead and zinc concentrates is 1.4¢ a ton-mile and for asbestos concentrates 1.8¢ a ton-mile.

not ship concentrates at this time. Rates for iron ore are based on long tons; for other concentrates on short tons.

ROAD TRANSPORTATION

In the north, as previously defined, only three roads (all in the northwest) can be considered as serving a major purpose to the mineral industry: the MacKenzie Highway from Grimshaw, Alberta, to Great Slave Lake; the Alaska Highway; and the Whitehorse-Mayo-Dawson Road. True, many lesser roads are in use, particularly for exploration and supply purposes on the southern fringe of the Canadian North, but the traffic (ton-miles) is not large.

Road construction costs will probably be less than railway construction costs. Furthermore, standards of road construction can be more easily lowered when funds are limited. Ton-mile operating costs on roads, however, will normally be higher than on rails, assuming competitive forces are allowed free play. This is shown by the Quebec North Shore and Labrador railway which has achieved economies by large scale operation which results in low rates. Rates on the Hudson Bay Railway and on the Northern Alberta Railways are reasonably low.

In many northern areas no large use of transportation facilities can be expected for some time. The main question, therefore, is whether air service is adequate or if a road should be built for a specific mineral movement. The three major routes cited earlier are used in some measure as trunk routes from which minor access roads can be located. Access roads which allow minimum inbound movement may cost \$3000 to \$10,000 per mile, depending on the terrain and availability of construction material such as gravel. All-weather, two-lane gravelled roads may cost up to \$60,000 per mile.

To avoid the cost of limited-use access roads, oil companies and others have engaged in research toward development of cross-country vehicles which will traverse all types of terrain. An essential requirement of such vehicles is a track pressure not greater than about two pounds per square inch. To achieve low track pressures, carrying capacity has

Table III. Northwestern Overland Transportation Costs

	Cents/Ton-Mile
Mackenzie Highway, northbound	7-12
Alaska Highway, northbound	8-12
Mayo-Whitehorse, southbound, concentrate	5-7
Motor roads, (gasoline trucks) connecting	
Hudson Bay Railway	20-25
Tractor Trains, re-supply	30-35

Sources: United Keno Hill Mines Ltd., Giant Yellowknife Gold Mines Ltd., Britannia Mining and Smelting Company Ltd., Snow Lake Division.

been sacrificed to some extent. Numerous vehicles have been developed, however, for cross-country travel with carrying capacities of one to twenty tons. The larger all-purpose vehicles have been thoroughly proven. Owing to low carrying capacity and high operating cost of cross-country vehicles, their use for large-scale southbound movement of minerals does not appear to be a sound proposition. Usefulness of these vehicles in exploration programs is firmly established.

Some typical ton-mile transport costs in the northwest are shown in Table III.

AIR TRANSPORTATION

The importance of air transportation to northern Canada cannot be over-estimated. As noted earlier, waterways, railways, and roads, serve only a small portion of the region involved, and therefore shippers must resort to use of aircraft for transport to outlying areas. Producers of gold and uranium are fortunate in some respects in that high-value products can be shipped out at relatively low costs. Location of gold and uranium mines in the north also enables producers to take advantage of lower cost seasonal water transportation for heavy supply shipments.

Most areas not near a river route have lakes close by which provide good landing fields for float-equipped aircraft in summer, and ski-equipped aircraft in winter. Construction of defense installations has resulted in a legacy of fine airports and attendant communication facilities, available for use by exploration and mining companies. Indeed, existing facilities for air travel make many exploration and development programs possible.

Air service over Canadian air routes may be of two types—scheduled service and charter service. Scheduled service companies publish a fixed tariff for passengers and freight over the routes flown. Charter service companies make available for charter the entire aircraft with crew at fixed rates per hour, day, month or mile. It is the responsibility of the charterer to make maximum use of the aircraft that is hired. The Directory of Canadian Air Services, published by the Air Transport Board in Ottawa, lists all commercial air carriers, showing base of operations and types of licenses held by each. Tariffs of licensed carriers are open to public inspection. By law such tariffs must show all extra charges for delays and for certain special types of flights.

Subject to the approval of the federal government's Air Transport Board, non-scheduled airlines operate out of bases which largely determine the area in which the carrier can operate economically. Non-scheduled airline companies arbitrarily divide the country into zones (generally radiating from each base) which carry different tariffs. As an example, zones of one airline based in Moosonee, Ontario, may overlap the zones of another airline based in Lac La Ronge, Saskatchewan. As a word of warning, with this situation a company could conceivably engage an aircraft which is based at an inconvenient point for the area to be serviced, and the charter rates for that particular service may be higher than that of an airline which is more conveniently based. The only certain method of ensuring the lowest possible charter rates is to obtain the tariffs of all airlines which are based in the vicinity of an operating area, then to compare the zones and rates within each zone of the various air-

lines. Zones and charter rates of the various airlines are more uniform for rental of large aircraft and helicopters.

Typical tariffs in effect early in 1960 for one company situated in north-central Canada appears in Table IV. It is obvious that maximum economy will be achieved if the volumes to be moved will justify full utilization of the largest aircraft. At any rate, cost of small hired aircraft on a ton-mile basis will be in the 40¢ to 60¢ range. For larger aircraft, the ton-mile cost may be lower if the aircraft is used to capacity. Some mineral producers have reduced their costs to about 19¢ per ton-mile by operating wholly-owned subsidiary airlines that use DC-4 airplanes. Part of the reduction can be explained by assured maximum utilization of the subsidiary.

Table IV. Typical Airline Tariff

Aircraft	Approximate Capacity (Lbs)	Mileage Rates, (\$ in Zones*)				Hourly Rates, (\$ in Zones*)			
		1	2	3	4	1	2	3	4
Cessna 180	1,000	0.45	0.50	0.68	1.32	51.75	57.30	101.20	151.80
Beaver	2,200	0.70	0.75	1.30	1.65	77.00	82.50	121.00	181.50
Douglas C47	9,000	1.25	1.25	1.55	2.00	200.00	200.00	248.00	320.00
DC 4	19,000	2.00	2.00	2.10	2.30	390.00	380.00	399.00	437.00

* Zones

- 1 South of latitude 54° 30' N
- 2 Latitude 54° 30' N to latitude 58° 30' N
- 3 Latitude 58° 30' N to latitude 70° 00' N
- 4 North of latitude 70° 00' N

Southbound movement from Uranium City is accounted for by shipments of uranium concentrates. The imbalance of northbound and southbound shipments to and from Yukon Territory and Northwest Territories is worthy of note, accounting in part for the higher rates on these routes.

Transportation in frontier areas is a major factor in total Canadian air freight. For example, in 1952 frontier aviation accounted for 99.1 pct of total ton-mile air freight; in 1955 and 1958, this percentage of total air freight was 92.3 pct and 89.6 pct, respectively.

Helicopter service is also available throughout northern Canada. Use of such service has been limited to supply of exploration projects and for certain airlift operations where landing fields are limited. Helicopters are more costly to operate per ton-mile than fixed-wing aircraft.

PIPELINE TRANSPORTATION

Thus far, pipelines have found only limited use in the far north. The only gas pipeline is that of Westcoast Transmission Company Limited which links the Peace River area gas fields of Alberta and British Columbia with British Columbia and Washington State markets. Completed in 1957, this 30-in. diam line is an important link between northern resources of natural gas and essential markets. The ultimate capacity of the present gas line is 660 million cu ft of gas daily. Farther north, new discoveries of gas within reach of the main gas line ensure continued throughput for the system.

During 1942 the U.S. Army constructed the "CANOL" pipeline system, linking the Norman Wells field with Whitehorse (Yukon Territory) and Haines Junction (Alaska). The line was operated for a period in 1943 as a war emergency measure. Part of the old "CANOL" pipeline between Haines and Whitehorse is now transporting oil from tidewater into the Yukon Territory. Capacity of this 4-in., 106-mile section is 3000 barrels per day, or roughly 2½ times Yukon's present consumption.

Ownership of the line within Canadian boundaries is vested in the Government of Canada. Operations of the entire line and ownership within the U.S. is by the White Pass and Yukon Railway. The remainder of the "CANOL" pipeline has been largely dismantled and sold.

The longest pipeline in the northwest is the 675-mile Haines-Fairbanks (Alaska) products line which cuts across the southwest corner of Yukon Territory.

Eventual extension of the Westcoast gas system toward Fort Nelson is assured. It may well be that energy from petroleum resources will play a part in making other mineral deposits more attractive. However, for the near future it appears unlikely that extensive pipeline construction will be undertaken in the north (the Westcoast system excepted) despite the favorable cost record of pipeline transportation in this area.

SUMMARY

It is of interest to note the existing relationship between the location of the several mineral producing areas in northern Canada and the means of transporting mineral products. Gold and uranium producers in the Central Access Division are supplied chiefly by water transport, yet the final products of the mines (gold bars and drums of uranium concentrate) are shipped out by air. Ton-mile costs of air transport are high, yet products which are valuable in relation to bulk are well able to absorb the cost. This position is improved if lower-cost subsidiary transport is operated.

In the Western Access Division, United Keno Hill Mines Ltd. and Cassiar Asbestos Corporation operate subsidiary truck transport from their respective mines to a railhead at Whitehorse which is 110 miles from tidewater at Skagway. Transportation arrangements in this area illustrate the complementary nature of road and rail transport under certain local conditions.

One producer in the Eastern and Arctic Access Division ships nickel-copper concentrates to Churchill, Manitoba by northern coastal shipping. This single operation has demonstrated the advantages of coastal shipping in reducing the cost of inbound and outbound shipments. Other mineral movements in the Eastern and Arctic Access Division are accomplished predominately by rail haulage. Where economies of scale have been achieved, favorable rates are in effect.

Considering the relative costs of existing means of transport, it appears that coastal shipping has some advantages where its use is possible. Choice of inland transportation would, for bulk movement of mineral products, probably be made between road and rail transportation. Excluding isolated local conditions, lowest transportation costs are borne by producers who rely on rail transportation. Road transport is more flexible but ton-mile costs are higher.

During the last 30 years, co-ordinated air, water, road, and rail transport has served as an adequate, but sometimes costly, means of transportation for northern areas. Existing transportation facilities within the access divisions demonstrate the superiority of railways as the backbone of an economical transportation system. As sufficiently large deposits are developed, construction of major railways will be justified. Other forms of transport can effectively complement the major railways to meet the problem of transportation—the principal challenge to northern development.

ROCK SALT MINING

OPERATIONS IN

MICHIGAN, OHIO, AND ONTARIO



by W. C. BLEIMEISTER

The rock salt deposits of the U. S. occur in five major basins: 1) the Eastern Basin (which includes parts of Michigan, Ohio, Pennsylvania, New York, West Virginia, and Ontario); 2) the Gulf Coast Basin (the northern rim of which includes parts of Alabama, Mississippi, Louisiana, Arkansas, and Texas, while its southern rim includes parts of the Isthmus of Tehuampetic and the Yucatan Peninsula of Mexico); 3) the Southwestern Salt Basin (which includes parts of Kansas, Colorado, Oklahoma, Texas, and New Mexico); 4) the Williston Basin (which underlies parts of North Dakota, South Dakota, Montana, and Saskatchewan), and 5) the Green River Basin (whose periphery underlies parts of Wyoming, Utah, and Colorado).

The greatest salt production in the U. S. is obtained from the Eastern Basin,—particularly from the areas of Michigan, Ohio, and Ontario. In 1958 the salt production from these areas amounted to 8.7 million tons or 35.3 pct of the combined total produced in the U. S. and Canada. Of the 24,286,000 tons produced by Canada and the United States, 6,443,000 tons were in the form of rock salt from dry mining, while 17,843,000 tons were produced from wells in the form of artificial brine, the result of dissolving the rock salt formation by fresh water.

Three important factors lie behind the location and development of this salt mining area:

- 1) A healthy market requiring salt for the meat processing industry, chemical industry, water softening and snow and ice removal from roads and highways.
- 2) An abundant salt formation at a reasonable depth and of sufficiently high quality to permit economical mining.

- 3) The availability of low cost water transportation on the Great Lakes which facilitates the movement of salt in Canada from eastern Saskatchewan Province to western Quebec Province, and in the U. S. from the "Dakotas" to western New York State.

As a result of the vastness of the formation, three of the five mines are located within the metropolitan areas of large cities, and the remaining two are located within easy communication of large population centers. This condition is somewhat unusual for the mining industry, where so many plants are forced to accept more remote locations. Although there are some disadvantages to an urban mine location, the easy availability of labor, supplies, contractual services, and good housing represent a great asset.

GEOLOGY OF THE SALT BASIN

The geology of the Great Lakes salt mining area consists of sedimentary deposits of shale, limestone, sandstone, dolomite, gypsum, anhydrite, and rock salt (halite). These formations within the mining area are relatively continuous and generally undisturbed by faults or other forms of sharp ground movements.

The salt formation, called the Salina Group, actually consists of a number of individual salt beds separated by layers of shale, dolomite, and anhydrite. The salt beds themselves contain bands of anhydrite which vary in thickness from 1/8 in. or less to measures of several inches. The anhydrite, calcium sulphate, will vary from a trace to approximately 2 pct by weight of the mined rock salt.

The top of the Salina Group of the Eastern Salt Basin varies in its vertical distance below the surface. For example, under Michigan the formation varies from a minimum of approximately 800 ft to a maximum depth of approximately 6800 ft, while

W. C. BLEIMEISTER, Member of SME, is Manager of the Cleveland Mine, International Salt Co., Cleveland, Ohio.



The loading and haulage equipment used in the International Salt Co.'s Detroit mine.

the top of the formation under Ohio, near the West Virginia boundary, reaches a maximum depth of approximately 6000 ft. This variation in depth is in part attributed to a gradual downwarp or sinking of the earth's crust into basins during formation of the salt beds. The five mines of the area are located at Goderich and Ojibway, Ontario, Cleveland and Fairport Harbor, Ohio, and Detroit. In general, these are on or near the rims of the basins, thus tapping the formation at the shallowest possible points.

SHAFTS

All of the shafts in the Great Lakes salt mining area are concrete-lined and extend through water-bearing zones or formations. The water conditions encountered at Detroit, Ojibway and Goderich are somewhat similar. The water-bearing zone starts at or near the top of the bedrock and extends to a depth of approximately 700 ft, involving limestone, sandstone, and dolomite formations.

The water at Cleveland and Fairport was encountered primarily in the Oriskany sandstone and reoccurred in the underlying dolomite.

At Goderich the water was, from a practical standpoint, fresh or sweet, while at the remaining four locations the water was actually a concentrated natural brine. At Detroit, Ojibway, and Cleveland this brine is capable of forming hydrogen sulfide gas upon its flow from the formation and its release to atmospheric pressure. The presence of the H₂S gas naturally complicated shaft construction.

Shaft construction through the water bearing zone was facilitated at Detroit and Goderich by injection of cement grout. The brine was sealed off by injection of chemical grouts at Fairport, and a combination of chemical grout and cement grout at Cleveland. The fact that the brine occurred at depth and was under high pressure, made the employment of grouting experts, as sub-contractors, extremely

desirable at Cleveland and Fairport. In the case of the Ojibway Mine, the ground was frozen prior to shaft sinking to a depth of 720 ft which included all aquifers. This was done with a series of freeze holes around the periphery of the shaft for lowering the ground temperature with refrigerant to a -4°F. With the waterbearing ground frozen the shaft was sunk in a conventional manner. Post grouting through the shaft liner formed the final water seal.

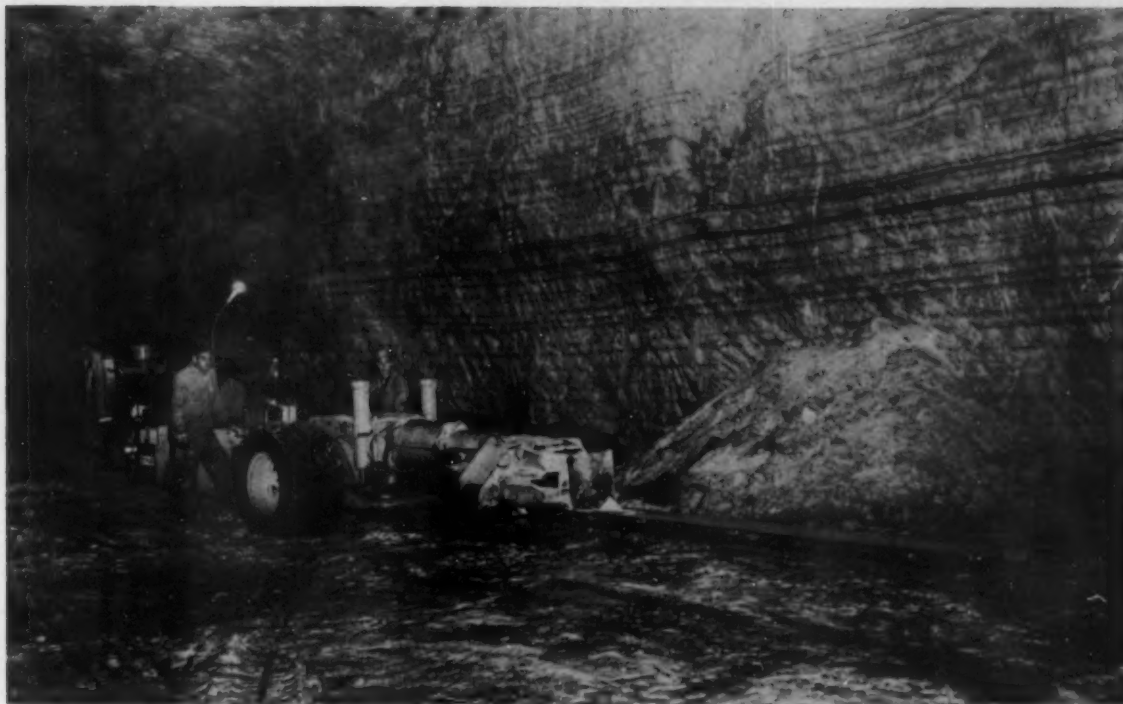
The main shafts, through which the salt is hoisted at all of the area mines are each haul 16 ft I.D. The secondary shafts used for ventilation as well as man and material hoisting are of varying size and shapes. The characteristics of the production shafts, as well as their fittings and hoisting equipment, is outlined in Table II.

VENTILATION

Since gaseous atmospheres do not exist in these salt mines, ventilation requirements have not particularly influenced shaft size or area. Aside from introducing fresh air for the miners, the ventilation systems are designed primarily to remove blasting fumes and diesel engine exhaust fumes. Each of the area mines is equipped with an adjustable pitch, axial vane-type fan capable of furnishing fresh air at between 100,000 and 125,000 cfm. At three of the five locations the fans are located underground. This arrangement not only simplifies shaft access but removes a source of noise which becomes a nuisance factor in an urban environment.

MINING

The room and pillar method of mining is employed in all salt mines in Michigan, Ohio, and Ontario. The rooms vary in width from 30 to 60 ft and in height from approximately 17 to 40 ft. Pillar size is adjusted so that the extraction or recovery will attain a maximum of 70 pct. Maximum percentage of extraction at Goderich, Fairport and



The type of cutter commonly employed in rock salt mining operations in the Eastern Salt Basin.

Cleveland will be less because of the greater depth and consequently increased support requirements for the overlying formations.

Actual mining is confined completely to the salt bed. Therefore, usually a minimum of 1 ft of salt is left on the floor, while 4 to 6 ft of salt is left to form the roof. Although this practice may appear wasteful, the advantages gained are considerable. First, the salt cuts and drills much easier than the overlying and underlying dolomites and/or anhydrite. Second, the salt also has much better bending strength characteristics than the anhydrite, which at times can be rather shaly and incompetent; therefore roof bolting is held to a minimum. Third, gas and natural brine pockets, which have been encountered in the rock separating the salt beds, are also avoided by confining the workings to the salt.

Generally speaking, the absence of gas, water, excessive dust, and the presence of sound roof and ribs as well as comfortable temperatures of 55° to 75°F, permit working conditions in a salt mine to be excellent.

UNDERCUTTING AND DRILLING

Today, excellent cutting and drilling equipment is available for salt mining. However, all of this equipment has some difficulty in the cutting of anhydrite. Therefore, an effort is made through selective mining to avoid this situation wherever possible. Unfortunately this cannot always be done, and when it becomes absolutely necessary to cut the anhydrite, both cutting time and bit consumption increase.

In undercutting, the chain speeds range from 516 to 610 fpm, while the cutting rate across the face varies from 6-in. to 8-in. per min, depending largely on the type of salt and its inclusions. In all cases the dimensions of the kerf are approximately ½-ft high by 10-ft deep.

The face drilling rate varies from 8 to 10 fpm, while the hole sizes vary from 1½ in. to 2¼ in. in diameter and from 10 to 16 ft in length. Rotational speed varies from 145 to 600 rpm and the thrust varies from 500 to 1400 lbs. The high percentage of customized drill equipment is attributed to the abnormally high working faces.

There is a variation or difference in blasting practice over the five mines within the area. Underlying some of the variations is the difference in loading equipment employed. At the Detroit mine, Marion electric shovels are used for loading and, therefore, the fragmentation can be coarser. At the other mines, continuous loaders are used which, of course, require a finer degree of fragmentation.

Another difference in the blasting practice occurs as a result of the explosive used. At Fairport and Detroit, a mixture of ammonium nitrate and fuel oil are used in conjunction with a dynamite primer; at Ojibway and Goderich, the more conventional 40 pct dynamite is used. The Detroit mine was the first salt mine in the U.S. to use ammonium ni-

Table I. Sequence and Thickness of Geologic Formations

	Goderich	Detroit and Ojibway	Fairport	Cleveland
Drift or overburden (ft)	40	86	45	106
Shale (ft)			1200	862
Limestone (ft)	200	333	300	537
Sandstone (ft)		90	4	78
Dolomite (ft)	725	362	300	143
Salt Thickness (ft)	413	460	300	314
Depth to top of salt formation (ft)	965	871	1880	1713
Depth to mining level (ft)	1700	1131	2025	1765

Table II. Production Shaft and Hoisting Data

	Goderich	Fairport	Ojibway	Detroit	Cleveland
Type of Hoist	Double Drum	Double Drum	Double Drum	Single Drum	Koepe
Diameter (in.)	144	144	144	84	132
Face (in.)	60	72	72	132	32
Drive (hp)	1500 (dc)	1250 (ac)	1250 (ac)	1000 (ac)	2000 (dc)
No. of Shaft Compartments	2	2	2	2	2
Guides (in.)	2½ x 7½ Timber	5½ x 7½ Timber	8 x 5 Timber	8 x 10 Timber	1½ Wire Rope
Buntions					
Size (in.)	10 x 10	12 x 12	8 x 12	10 x 10	
Vert. Spacing (ft)	7½	7	7	5	
Skips	2	2	2	2	2
Size (tons)	13	9	10	10	20
Material	Aluminum	Aluminum	Aluminum	Stainless Steel	Steel
Rope Size (in.)	19/16	2½	1½	1½	1½ (4 ropes)
Rope Speed (fpm)	1500	1380	1380	1600	1475
Capacity (tph)	370	300	500	500	700

trate extensively for blasting, and the perfection of this development has resulted in improved safety conditions, as well as greatly reduced cost. (See MINING ENGINEERING, April 1961, pp. 377-378). At all mines multiple delay aluminum shell blasting caps are used. Iron blasting wire is also used for easy removal by magnets from the broken rock salt.

Blasting patterns, of course, vary from one mine to the next, but in general, all patterns include rib and roof holes which are about 11 ft deep and angled out or up respectively about 15 in. These holes are usually spaced on 5-ft centers, except at the corners where the spacing is reduced to about 2 ft. The balance of the holes are placed in 2 to 3 rows, depending on the height of the face. The rows are about 5 ft apart vertically while the hole spacing horizontally varies from 5 to 10 ft. Because of the undercut, the bottom row is located from 6 to 10 ft above the floor and dips down so that the end of the holes are only 20 to 30 in. above the undercut. Depending on the slope, the hole depth in the bottom row can be as much as 16 ft.

LOADING AND HAULAGE

Three distinct combinations of loading and haulage equipment are used in the Michigan, Ohio, and Ontario Salt Mining Areas. The oldest system is in use at the Detroit mine and includes three, 2½-cu yd Marion ac electric shovels with dc controls, which load six 22-ton capacity, combination battery and trolley powered Euclid bottom-dump trailers and tractors. These trucks travel 1½ miles from the face of the Detroit mine to the primary crusher. Most of this distance is over excellent roadways with power being furnished from 250-v, dc trolley lines. Advancement of the trolley lines is maintained so that the distance from the end of the trolley to the working face does not exceed 700 ft. Power for this segment of the trip is derived from storage batteries, recharged after every two shifts of operation.

Table III. Cutting and Drilling Equipment

Undercutting	Goderich	Ojibway	Detroit	Cleveland	Fairport
11-ft Cutter Bar	X	X	X	X	X
5 Position Cutter Blocks	X	X		X	X
7 Position Cutter Blocks			X		
Carbide Bits	X		X	X	X
Throw Away Bits		X			
Kerf	6 in.	5 in.	5½ in.	6 in.	6 in.
Drilling					
Hydraulic Drills	X		X	X	X
Electric Drills		X			
Hydraulic Feed	X	X	X	X	X
Standard Rig	X			X	
Custom Design Rig	X	X	X		X
Carbide Bits	X	X	X	X	X

The loading-haulage system at Goderich, Ojibway, and Fairport are similar since they each use large continuous loaders and rocker type, rear-dump trailers pulled by two-wheeled diesel-powered tractor units. These trucks have a capacity of 10 to 22 tons each.

The diesel truck equipment increases the ventilation requirements to a greater extent than the electric trucks. On the other hand, the diesel-powered trucks offer greater flexibility and ease of operation, which of course is very desirable in a new mine.

All of the systems are designed for reasonably long distance hauls. The combination of the continuous loading machine and the rear dump truck is quite natural since the trailers are short, deep, and wide, and the open rear end allows the boom conveyor of the loading machine ample room for placing the load.

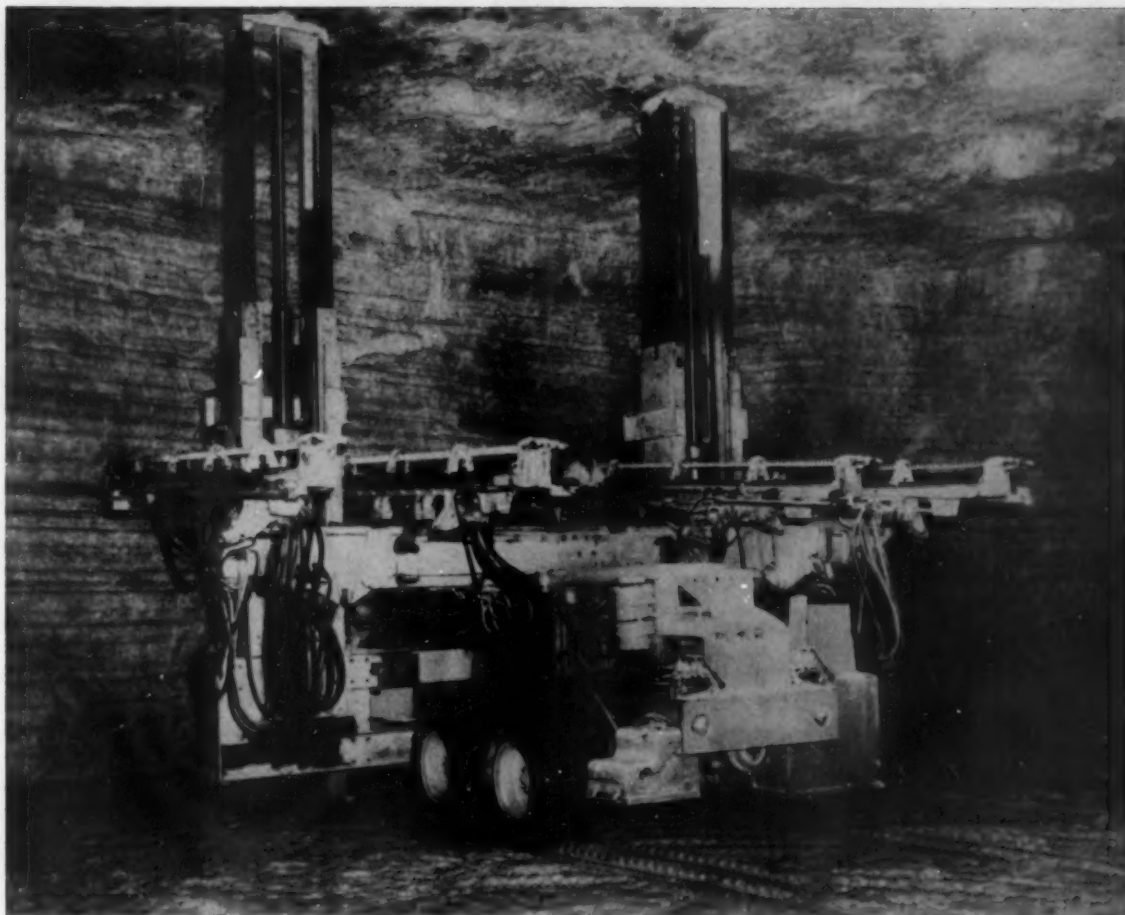
The loading and haulage system planned for the Cleveland mine is completely different from those previously covered. It employs the 11 BU Joy continuous loading machine and the 60H20-1 Joy ac electric-powered shuttle car, having a capacity of 16 to 18 tons. Power is supplied to the cars by trailing cable, and therefore the system can be classified as having a short range. It will be used in conjunction with a main line haulage system employing either belt conveyors or very large trucks of 50 tons or more capacity. This latter part of the system will be installed after further development work has been completed.

The shuttle cars were also selected for operation with the Goddman Model 250 Continuous Boring Machine, the first machine of its type to be specifically designed for operating in rock salt. The machine weighs 50 tons and is powered by two 250 hp, 440-v, ac electric motors. It employs two rotary heads fitted with eccentrically mounted breaker discs and cutting bits for making an opening 7½ ft high by 13 ft wide. Trim chains on the top and bottom make the opening an almost perfect oval with relatively flat roof and floor sections.

PREPARATION

The exceptionally fine underground conditions at each of the mines mentioned in this article make it possible to carry on activity underground which is normally associated with a surface plant. Processing is one such activity. At Detroit, Fairport, and Ojibway, screening and crushing is divided between surface and underground facilities. In general, the finish-screening is located on the surface, while most of the crushers and scalper screens are located underground.

The Goderich and Cleveland mines presently have temporary crushing and screening facilities on the



An hydraulic drill jumbo at work at the Detroit mine.

surface, but these will be removed after the installation of complete processing facilities underground. These underground facilities will include provisions for the storage of finished grades of salt, which will be hoisted only upon demand. Although the processing facilities at Detroit are split, the mine has an extensive underground 150,000-ton capacity storage facility for finished and semifinished grades.

Processing is similar at each of the five mines in the area. Crushing involves primary, secondary, and in some cases, tertiary stages, plus crushing of oversize and grinding of some of the larger finished sizes. Coarse crushers are single roll-type with the exception that impactors are in use at Goderich, Fairport, and Cleveland. Fine crushers and grinders are all double roll type.

Screening is carried out in two stages: scalpers, for separating the oversize from the "No. 2 grade" (approximately $\frac{1}{2}$ x $\frac{3}{8}$ in.) and from the minus $\frac{3}{8}$ in. mixture. Tail screens separate this mixture into "No. 1 grade" (approximately $\frac{3}{8}$ to $\frac{1}{4}$ in.), "CC" grade (approximately $\frac{1}{4}$ -in. to 11 mesh), and "PC" grade (minus 11 mesh).

Although partial beneficiation of salt by selective impact crushing is being done at some mines, the only refined process is in use at the Detroit mine. This is the thermoadhesive method of beneficiation which employs an infrared heat source for differentially heating the salt and anhydrite particles. (See MINING ENGINEERING, August 1960, pp. 913-

921). The anhydrite, which absorbs more heat, adheres to a heat sensitive, adhesive-coated conveyor belt. Since the relatively cool salt particles do not adhere, they are separated from the anhydrite at the end of the conveyor.

A compaction process for converting "FC" grade salt into coarse flake-like particles is in operation at the Fairport mine. This process involves passing pre-heated fine salt between a pair of heavily spring-loaded Allis-Chalmers flaking rolls. The discharge from these rolls, which is in sheet form, is crushed and screened to produce a particle size of approximately $\frac{1}{4}$ x $\frac{1}{4}$ x $\frac{1}{8}$ in.

The Fairport mine is the only mine in the area which is endeavoring to utilize or convert the "FC" grade of salt which reaches surplus proportions at all five mines. At the other mines, this surplus material is used for building underground roadways and stoppings for the mine ventilating system. It is interesting to note that this surplus, which may be approximately 15 pct of the total material mined, is about the only waste from the salt mining operation.

SUMMARY

The five mines situated in the Michigan-Ohio-Ontario area of the Eastern Basin have ample reserves to allow both long life and heavy production. The present operations of these mines are so geared that there can be little doubt of this area maintaining its position as the primary source of salt for a period extending far into the future.



BENEFICIATION OF ISRAELI PHOSPHATE ORE

by ITZHAK HOFFMAN and BURT C. MARIACHER

In 1952, beneficiated phosphate ore first began to move from the Oron plant of Negev Phosphates Ltd. in the Negev Desert to the super-phosphate plant at Haifa, Israel. Since that time this company has continually sought to overcome its natural handicaps affecting the operating efficiency and quality of the product in an effort to bolster the agricultural program of Israel and the development of an exportable commodity.

The most serious deterrent to the development of a beneficiation process was the total absence of water. The Oron plant lies approximately 30 miles south of the irrigated regions of Israel with the nearest producing water well located about 10 miles to the northwest. The urgency of early phosphate production made it necessary to consider only dry processes in the initial operation. Fortunately, the ore was amenable to a dry process which yielded a usable concentrate assaying about 28.5 pct P_2O_5 ; but phosphate recovery was low. A description of the characteristics of the Negev ore should help to clarify the principles upon which the dry concentration is based.

THE PHOSPHATE ORE AT NEGEV

The phosphorus-bearing mineral of the Negev ore is believed to be a carbonate-apatite-fluoride ($Ca_5(PO_4)_3 \cdot CaF_2$) which occurs as oölitic particles in a size range of approximately minus 35-mesh to plus 200-mesh. The cementing material between the oölitic is calcite. These two minerals constitute the principal ingredients of the phosphate beds, with

minor amounts of gypsum, halite, and quartz normally present. The phosphate oölitic are chalky in texture; although they are relatively soft, breakage is generally confined to the cementing material between the oölitic. The phosphate beds occur between beds of chert and calcite, and these two materials are always present in the mined ore. The ore, mined by open pit methods, can be broken up adequately by shovels alone, eliminating any need for explosives.

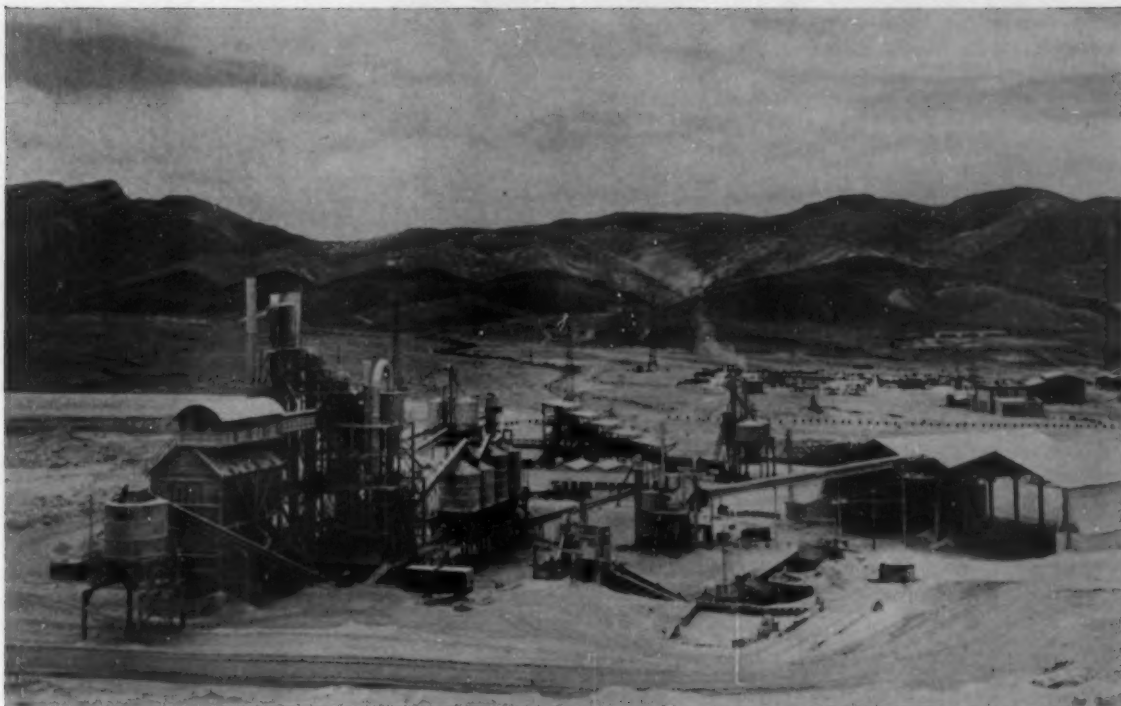
DRY CONCENTRATION PROCESS

The dry concentration process utilizes the hardness differential which exists between the phosphate oölitic, their calcareous cementing material, and the free chert and limestone particles. The open pit mining operation at Negev is not required to reduce all ore to primary jaw crusher feed opening size because pieces which are too large to feed the crusher are usually low phosphorus limestone or chert fragments which are rejected. The material suitably sized for crushing is reduced to minus 4-in. size in conventional, two-stage, open circuit crushing.

The crushed ore fed to the beneficiation plant assays approximately 23 pct P_2O_5 . The ore is initially sent to a dry scrubber which consists of a rotating drum on a horizontal axis having proportions similar to a rod mill. With no rod charge, it performs a function which is a combination of autogenous grinding and scrubbing of the oölitic phosphate particles. The discharge from the scrubber is sized at approximately minus 1 1/2 in. A narrow size fraction of approximately minus 28-mesh to plus 200-mesh contains concentrated phosphate of usable quality.

The scrubber discharge is processed in a system of screens, air classifiers, and dust cyclones to reject

I. HOFFMAN, Member of SME, is Technical Consultant, Industrial Development Corp., Haifa, Israel. B. C. MARIACHER, Member of SME, is Manager of the Metallurgical Division, Colorado School of Mines Research Foundation, Inc.



View of the phosphate processing plant of Negev Phosphate Ltd., located in the heart of Israel's Negev Desert.

the coarse and fine size fractions. These reject sizes, by no means barren of phosphate, have been systematically stored for future treatment.

The concentrate is transported 140 miles north to the port of Haifa for processing to super-phosphate, or is sent a similar distance south to the Red Sea. There is some market for direct application of the fine rejects from the dry concentration plant which assay approximately 23 pct P_2O_5 . This material is nominally minus 200-mesh with a small fraction of material as coarse as 65-mesh.

THE ADVENT OF WATER

The tremendous reserves of phosphate ore in the Negev area present an attractive commodity for export to European and Far East markets. However, the grade of concentrate obtainable by the dry concentration process is not adequate to satisfy these markets. An intensive study of dry concentration methods failed to result in any substantial improvement in grade of concentrate or in rate of phosphate recovery.

The management of Negev Phosphates, Ltd. concluded that the task of bringing water to the Oron phosphate field was an inevitable necessity. Consequently, as early as 1955, studies were under way to develop a process, using water if necessary, which would produce a concentrate that would be suitable for export.

Perhaps the greatest need for water in the beneficiation process is to accomplish efficient desliming of the ore. When crushed to the oolite liberation size or approximately 35-mesh, the ore will contain about 40 pct minus 400-mesh material. The percentage of these natural slimes is not significantly reduced by even the most extreme measures of slow-stage reduction. Containing a concentration of calcareous cementing material and clay assaying about 18 pct P_2O_5 , they interfere with all beneficia-

tion processes by coating the phosphate particles and by consuming reagents. Efficient wet scrubbing and desliming have been found to be an essential phase of all beneficiation processes.

DEVELOPMENT OF FLOTATION METHOD

Preliminary investigations of wet concentration methods failed to produce any appreciable phosphate concentration except by flotation. Fatty acid collectors, principally a high purity oleic and linoleic acid, produced the first satisfactory results. It was determined that carefully regulated quantities of the collector would float the calcite from the phosphate in a deslimed pulp. Opportunities for extensive conditioning of the pulp were limited because pulp agitation rapidly produced slimes which consumed reagents and which resulted in only slime flotation. The simplest and most satisfactory procedure consisted of the addition of the collector only, immediately followed by a short flotation time. Slimes generated in the flotation cell after the primary flotation of calcite did not pose a serious problem, as they were generally of lower grade and floated with the calcite.

Subsequently, it was found that naphthenic acid was a considerably more satisfactory collector, being more selective in floating calcite. It was capable of producing a concentrate containing 31 to 32 pct P_2O_5 with recovery of approximately 87 pct of the phosphate in the flotation feed. However, a thorough canvass of past suppliers of naphthenic acid disclosed that this material was becoming increasingly scarce, and no commitments for continuing supply could be obtained. Short chain saturated acids (principally capric acid) proved to be suitable substitutes, but a more satisfactory collector, both metallurgically and economically, was a synthetic carboxylic acid termed "Kadimic" acid, manufactured in Haifa.

The sliming properties of this phosphate material and the adverse effect of slimes in the flotation pulp made it desirable to employ a short, simplified flotation procedure. The chalky nature of the ore particles did not make them amenable to complex surface conditioning, and collector coating was the only surface alteration technique that proved to be significant. Pulp temperature and the composition of the water were about the only features of the process which had significant effects on the metallurgical results.

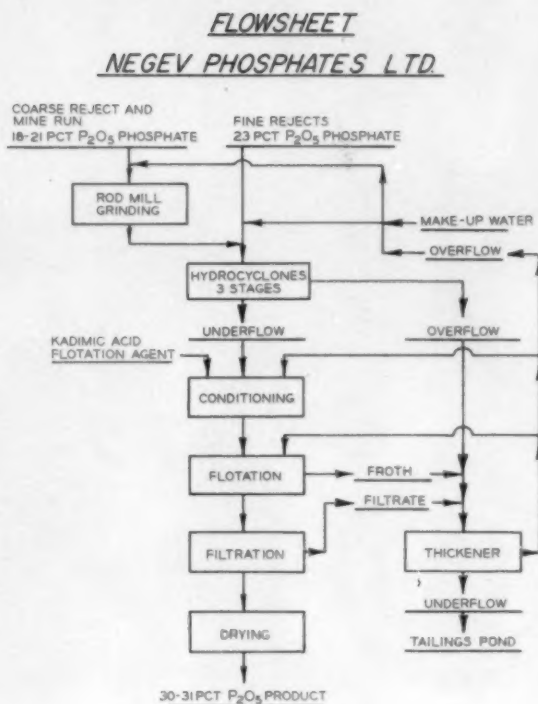
The elevation of pulp temperature to about 35°F generally improved the selectivity of the separation and improved the physical properties of the froth. The froth column was stabilized for a longer period of time to permit more workable flotation time; it had greater strength, and would develop a deeper froth column than could be obtained by flotation at ambient temperature. However, the economics of heating the flotation pulp were very unfavorable because of the scarcity of fuel. Extensive studies of the flotation technique at the company laboratories in Israel ultimately developed a process employing Kadimic acid which resulted in satisfactory froth properties and metallurgical results shown below:

Collector	Pulp Temperature, °C	Concentrate Analysis P ₂ O ₅ Pet	Pet Recovery P ₂ O ₅
Naphthenic Acid	33-38	31.9	87.0
Kadimic Acid	20-25 (Ambient)	31.0	80.0

The flotation process employing naphthenic acid, when first tested in water similar to that which would be available at Oron, was found to be completely unsatisfactory because of "hard water" effect. No workable froth formed on the pulp and the meager material that could be skimmed from the pulp surface was a very inferior product. It was obvious that water treatment would be required to obtain a workable process with Oron water.

The plant water for Oron contains Ca⁺⁺, Mg⁺⁺, Na⁺, HCO₃⁻, SO₄²⁻, Cl⁻ in significant amounts, but the HCO₃⁻ was suspected to be the principal interfering element. It was found to occur in amounts as high as 380 ppm. This problem was readily overcome with simple water softening chemistry. The addition of lime to produce a flotation pulp pH of about 10.0 proved to be a satisfactory solution. Besides neutralization of HCO₃⁻, the increase in pH probably also lowered the concentration of magnesium and, perhaps, other interfering ions. The benefits from heating the flotation pulp may also have partially resulted from HCO₃⁻ decomposition, as it was found that heated water, after cooling to ambient temperature, gave more satisfactory results than the natural water.

Reclamation of plant water was to be an essential part of the flotation plant process. Suspected problems arising from an accumulation of Ca⁺⁺, Mg⁺⁺, and Cl⁻ ions were investigated by laboratory cycling tests in which the water from cyclone desliming was reclaimed and reused in several flotation stages. Filtrate samples were analyzed after each stage. The concentration of these ions became fairly constant after about three stages of use, and subsequent flotation results actually improved. The chemistry of this effect has not been fully established, but it became apparent that reclaimed water was more desirable for flotation than fresh water. Although soluble constituents of the ore increased the concentration of some ions, these were not harmful,



and the interfering ions in fresh water were neutralized after contacting with the ore and flotation reagents.

The results of these tests changed the initial—and usually normal—plan of adding fresh water to the flotation circuit. Instead, the fresh water was added to the cyclone desliming circuit and reclaimed water added to the flotation circuit.

The potential feed to the wet beneficiation plant could be one of three types: namely, run-of-mine ore; coarse rejects from the existing plant; or fine rejects from the existing plant. Initially, the flotation plant was designed for treatment of the latter because it required no crushing or grinding, and production could be achieved most quickly without any interruption of the present dry plant operation.

A 300-tpd wet beneficiation plant was constructed in 1958. The flow-sheet is quite simple, consisting of three stages of cyclone desliming followed by a single stage of flotation. The phosphate oolites have excellent filtering properties and the flotation concentrate requires no thickening. The filter cake is dried in a conventional rotary dryer. The addition of a crushing and grinding circuit will provide a plant suitable for treating the existing coarse rejects and run-of-mine ore.

SUMMARY

The phosphate deposits of the Negev Desert promise to develop into one of Israel's principal industries. The existence of many natural handicaps, such as lack of water, shortage of domestic sources of fuel, and the isolation of the area from habitation present many problems which must be, and are being, solved. Long-range programs have been planned to develop methods for conservation of this natural resource by improved efficiencies, to expand production capacities, and to market a product of highest quality.

ECONOMIC ASPECTS OF INTERRUPTION OF DIAMOND PRODUCTION IN CONGO REPUBLIC

by ARTHUR F. DAILY

Free World consumption of diamonds of all types closely follows the fluctuations of the business cycles in the large industrialized countries, particularly the U.S. Sustained purchasing by this country for stockpiling purposes has been a major factor in Free World demand for crushing bort and industrial diamonds, and it has been for this reason that investments in larger plants have been made by all major diamond mining companies during the past few years.

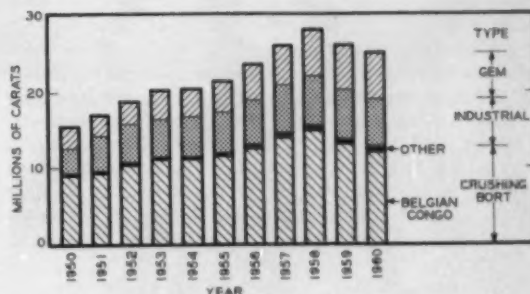
For the purposes of this study, the diamonds produced in the Congo and elsewhere in the Free World are divided into three types:

Gem: A diamond of which any portion is usable for cutting and polishing for use in jewelry; trade synonym—cuttable.

Crushing bort: A distinctive type of industrial diamond having a confused or radial crystal structure, lacking distinct cleavage planes, and suitable for use only in crushed condition.

Industrial: All diamonds not included in the two types described above, including stones large enough for individual setting in tools in natural or shaped form, and those too small for such use.

The importance of diamond production from the Congo Republic is underscored by Table I. The Congo provides 96 pct of the Free World's supply of crushing bort of which 46 pct is imported to the U.S., and 19 pct of the Free World's production of industrial diamond. Thus it is readily seen that should a protracted interruption of production occur in the Congo Republic, or should the Communist Bloc gain control of this area, it would deal a very serious blow to American and foreign industry. This is particularly true when one realizes that the 1960 diamond inventory of the Central Selling Organiza-



tion (controlled by DeBeers) which has marketed 85 pct of world production for many years, amounted to only normal trade inventories sufficient for a few months. If production were to cease for any prolonged period, or if diamond production should be directed to the Communists, the supply of crushing bort would be exhausted within a few months and the industrial diamond supply would be insufficient to satisfy Free World demand.

DIAMOND MINING PROPERTIES

Diamond mining in the Congo Republic is conducted in two distinct localities in the now well-known Kasai Province; one in the south central portion centered around the town of Tahikapa, and the other in the southeast part within a few miles of the town of Bakwanga. The two districts are about 200 miles apart by air and 300 miles by road. Diamonds were discovered in the Tshikapa district in 1909, and at the Bakwanga district in 1918. Thereafter, operations were established and have been conducted continuously on an increasing scale, except for the interruption beginning in 1960. In the Tshikapa district the mining concessions are held by the Belgian-controlled companies, Societe Miniere du Beceka (Beceka), Societe Internationale Forestiere et Miniere du Congo (Forminiere), and the consortium of small companies known as Entre-Kasai-Luebo (E.K.L.). In the vicinity of Bakawanga

A. F. DAILY, Member of SME, is a Consulting Mining Engineer, Oakland, Calif. Paper presented at the AIME Southwest Mineral Industry Conference, Las Vegas, Nev., April 25, 1961.



Tram used for transporting gravel from mine to plant.

the concessions are held by Beceka. All operations in both localities were conducted under contract and in the name of Forminiere until 1 January 1961 when Beceka took over management at Bakwanga on its own account.

Tshikapa: In this district, mining is carried on at about 55 separate places, scattered over an area about 140 miles long from north to south and 25 miles wide. All the deposits are alluvial. (For that matter, 85 pct of world production of diamonds is mined from alluvial deposits). The overburden is removed by hand, hydraulic or mechanical methods, and the diamondiferous gravel is excavated by hand or mechanical methods. The gravel is washed, screened, and concentrated by clearwater panning and jigging at a field plant at each mine. The concentrate is transported by truck each day to the central recovery plant or picking station at Tshikapa for subsequent stages of concentration and final hand picking of the diamonds.

Bakwanga: Within a few miles of Bakwanga, mining operations are conducted at eight places in alluvial deposits and at one or two sites in weathered kimberlite rock. Stripping and mining are highly mechanized, but the bedrock under alluvial deposits always is cleaned by hand. Until July 1959 the excavated material was concentrated at each mine in a field plant similar to those used at Tshikapa, except for a special plant for concentrating sticky weathered kimberlite. The concentrate was then transported to the central recovery plant. In December 1959 a large central concentrator, designed for treatment of a mixed gravel and kimberlite head feed, was completed at a cost of almost \$9 million. It is expected that this plant will gradually supersede part or all of the field plants. The Bakwanga property produces approximately 58 pct (by weight) of world production of diamonds, and the rate of production since 1956 has averaged about 50,000 carats per working day. Proven reserves are estimated to be at least 500 million carats.

INTERRUPTION OF OPERATIONS IN CONGO REPUBLIC IN 1960

During the first six months of 1960, production at Bakwanga was at the record rate of 1,500,000 carats per month. As a result of civil disturbances following granting of independence on 30 June 1960, operations decreased thereafter and ceased on 27 August. In the latter part of October, as Congolese employees returned to work, mines were gradually

reopened and almost full scale operation was achieved in December, resulting in production for the year of 13 million carats. At Tshikapa normal operations were conducted until July, then mines were closed, until only four of the fifty-five were active in August and September. Thereafter operations were resumed gradually but had not reached full scale by the end of the year. Production was estimated at 400,000 carats.

The distinction between *gem* and *industrial* diamonds is not clearly defined, depending somewhat on market demand for their respective uses. The diamonds mined in the Tshikapa district are about 30 pct *gem* and 70 pct *industrial*, and at Bakwanga are 2 pct *gem*, 5.5 pct *industrial*, and 92.5 pct *crushing bort*.

PRODUCTION AND USES

A graphical presentation of world diamond production by the types described above for the years 1951 to 1959 inclusive is shown on page 475. During this period, the contribution from the Belgian Congo amounted to 60 pct by weight, but only 15 pct by value because 83 pct of total output was the comparatively low-valued crushing bort from Bakwanga. However, as noted above, the Belgian Congo accounted for 96 pct of world output of crushing bort, and 19 pct of total industrial output, a significantly high figure.

During the period 1950 to 1958 inclusive, Free World production of diamonds increased by an average weight of 1,550,000 carats per year, approximately 50 pct of which was accounted for by Belgian Congo, Bakwanga property. In 1959 production at Bakwanga was 1.8 million carats less than in 1958, but all other countries produced about the same amount as in 1958. The reason for the decrease at Bakwanga has not been made public, but it was *not* due to lack of reserves. The reason for lack of increase in other countries appears primarily to be due to completion of major expansions and improvements of recovery methods under way for several years at the large mines.

Uses of Industrial Diamond: Crushing bort, used principally as a component in abrasive grinding wheels, is sold in the form of the coarsest grit or powder size commensurate with the desired finish. It is also used in various types of tools and as a polishing material. Industrial stones of suitable shape and quality, weighing from 1/20 carat to



Field prospecting camp in Tshikapa District. Men are washing and screening gravel in multi-deck rocker screens.



View of a cut at a small mine in the Katapa District of the Congo Republic. The district covers 3500 square miles.

1 carat, are used in core, oil well, and borehole bits. Good quality, shaped, and polished industrial diamonds weighing from $\frac{1}{4}$ carat to 4 carats each are used for lathe, thread, and gear-cutting tools. Those of the best quality, and weighing from 10 points per carat to 1 carat, are used for wire drawing dies. Those that are very small or unsuitable for the uses described above are employed in natural or crushed form for polishing or grinding. Over a hundred grades of both crushing bort and industrial diamonds are recognized.

Synthetic Diamond: Since the announcement by the General Electric Co. in February 1955 that synthetic diamonds had been made, the company has produced them commercially on an increasing scale. Almost all of the synthetic product has been in the form of single crystals of which 95 pct are minus 40-mesh. Recently it was announced that stones larger than 1 carat had been made but of a quality unsuit-

able for use as single stones. For some applications the General Electric product is competitive with certain sizes and grades of crushing bort, and it exhibits superior qualities in diamond impregnated resinoid and vitrified grinding wheels. From the latter part of 1950 through 1960, the selling price was the same as the basic London selling price of crushing bort, \$2.80 per carat. Early in 1960, prices of \$2.74 per carat for orders of 10,000 or more carats and \$2.40 per carat for ungraded fines were announced. Statistics on production have not been released but, according to an unconfirmed press report, the output was about 750,000 carats in 1958 and 1,000,000 carats in 1959. Apparently the entire production has been sold without causing an identifiable effect on imports of crushing bort.

In November 1959 DeBeers Consolidated Mines Ltd. announced that synthetic diamonds of the type manufactured by General Electric had been made in its Adamant Laboratory in Johannesburg. In October 1960, DeBeers announced that it had decided to proceed with commercial production, with participation by Soc. Minière du Beceka, at a plant to be constructed in the Union of South Africa.

U.S. DIAMOND CONSUMPTION

Crushing Bort: During World War II a tremendous increase in the demand for crushing bort and industrial diamond developed in the U.S. Production at the Bakwanga property was increased as rapidly as possible, and the product transported by air to this country. Following a short period of decreased usage after the war, a renewed and increasingly strong demand arose. Production of crushing bort at Bakwanga rose from 9.3 million carats in 1951 to 14.8 million in 1958, and during the first six months of 1960, was at the record rate

Table I. Average Annual Statistics of Diamond Production (1956 through 1959)

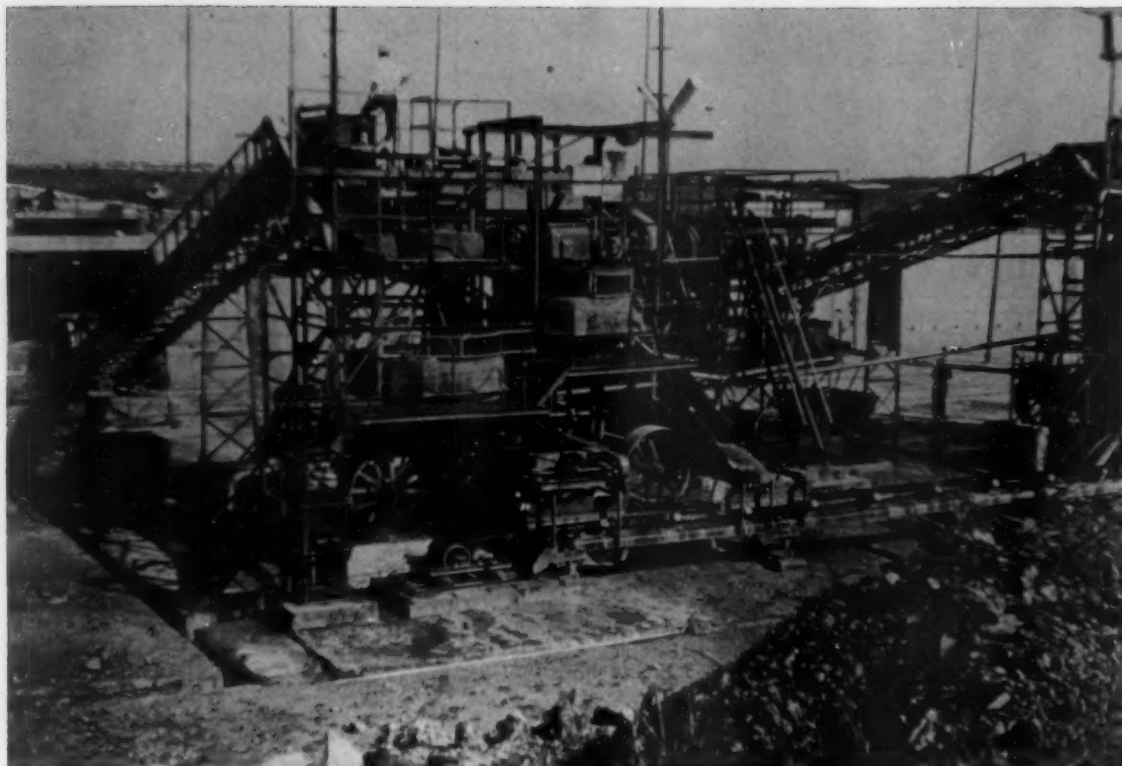
	Belgian Congo		Free World	U.S. Imports ¹	
	Wt	Pct of Free World	Wt	Wt	Pct
Crushing Bort ²	13.55	96	14.17	6.47	46
Industrial Dust ³	1.25	19	6.46	6.11	94
Gem ⁴	0.48	9	5.37	2.90	54
Total	15.28	59	26.00	15.48	

¹ From USBM statistics; include stockpile program purchases.

² Type suitable for use only in crushing form for industry.

³ Assumed to be derived from rejects from shaping of gems and industrial stones.

⁴ Known to include a portion actually used for industrial purposes.



Unit of field washing and concentrating plant specially designed for treatment of sticky, weathered kimberlite.

of 18 million carats per year. Because of its strategic importance, the absence of satisfactory substitutes, and complete dependence on foreign sources, the U.S. has purchased crushing bort for an emergency supply inventory continuously since the end of World War II.

During the period 1952 to 1959, imports of crushing bort into the United States (including purchases for stockpiling) amounted to an average of 7.3 million carats per year—about 57 pct of Free World production. A portion of this imported material was processed and re-exported from the U.S. Industry demand for crushing bort in the U.S. is estimated to be at least 5 million carats per year.

Industrial Diamonds: For the years 1952 through 1959, the weight of industrial diamonds imported into the U.S., including those purchased for stockpiling, was practically the same statistically as Free World production and averaged 5.8 million carats per year. Of course industrial diamond is consumed in countries other than the U.S.; the difference between actual Free World consumption and statistical consumption in this country is partially accounted for by stones initially classed as gems for statistical or customs purposes, and partially by sale from inventory by the Central Selling Organization during the earlier years of the period. At times some uncertainty regarding the adequacy of industrial diamond supply has been expressed, but in 1958-59, during the slight depression in the U.S. and when stockpiling purchases were temporarily discontinued, a small inventory was accumulated by the Central Selling Organization. The actual current industry demand in the U.S. is presently estimated to be at least 4.5 million carats of industrial diamonds per year.

Gem Diamond: In terms of weight of rough gem diamond, it is estimated statistically that, since 1953, an average of 55 pct of Free World production has been imported into the U.S., and in 1959 it was 63 pct or 3.7 million carats. Actually, the percentage imported is higher (perhaps about 80 pct) because a significant weight of stones statistically classed as gems are used actually as industrials.

ECONOMIC ASPECTS OF SUSPENDED DIAMOND MINING OPERATIONS

In considering the effect of indefinite suspension of Congo diamond mining on sources of supply for the U.S. market, the influence of purchases of crushing bort and industrial diamonds for stockpiling is an important factor. For estimating the results of such a situation, it is assumed that purchases for stockpiling would be discontinued to avoid creating a heavy demand on the market and consequently on diamond prices. Though data on the quantity purchased for stockpiling are not released, an allowance has been made in the following estimates.

Crushing Bort: Virtually no crushing bort would be available to meet Free World demand. The logical substitute for particle sizes smaller than 40-mesh would be synthetic diamond, though for many uses it is not as satisfactory as the natural product. Demand for larger particle sizes could only be supplied by crushing industrial or marginal quality gem stones; perhaps satisfactory synthetic stones will be made in larger sizes than at present. Other natural or synthetic abrasives would also be used as a substitute for some purposes.

Therefore, one result would be a very great increase in the demand for synthetic diamond. Doubtless, General Electric would rapidly increase its



A Lubeck Rotopelle bucket wheel digger used for stripping overburden from diamondiferous alluvial deposits.

output, DeBeers in conjunction with Beceka would rapidly become a major producer, and perhaps other companies would engage in manufacturing. The effect on price of synthetic diamond is unpredictable; a large increase in production could lower unit costs. Presumably the market for synthetic diamond as a substitute for crushing bort would become satisfied within a relatively short time, and sales by manufacturers would become highly competitive. If, at a later date, production of crushing bort should be resumed at Bakwanga, a very competitive price situation would develop between synthetic and natural products. Probably crushing bort could be sold profitably at a price somewhat below the \$2.80 per carat of 1960.

Industrial Diamond: Free World production would be perhaps slightly higher than normal Free World demand. A very strong increase in demand would occur for use as a substitute for crushing bort, in particle sizes larger than the synthetic diamonds now being manufactured, and in smaller particle sizes for uses for which synthetic diamond is not a satisfactory substitute. The anticipated net result is a serious shortage, a condition that usually leads to increase in price. Most of the mines in the world now are producing at or near the maximum capacity of installed plant facilities, so no significant increase in production could be realized without plant expansion. This would be expensive, and probably undesirable, at most properties. At some mines an increase in the number of work shifts might be possible, but this would create difficult problems of recruiting, training, and housing of additional personnel.

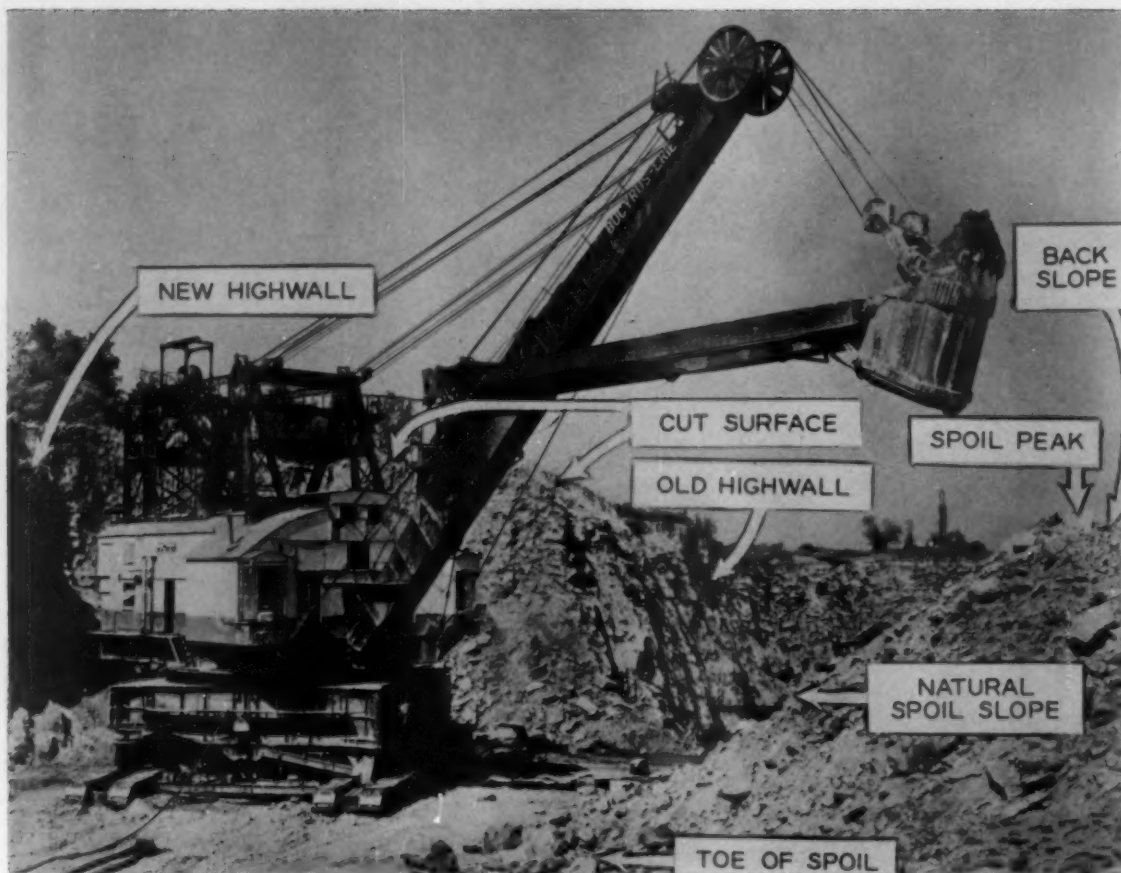
Gem Diamond: The decrease of Free World production of gem diamond caused by prolonged cessation of mining in the Congo Republic would be 9

pct according to the statistics cited above. However, the actual decrease would be about 25 pct for reasons of statistical classification as explained above. A definite shortage therefore would arise, because of the continuing demand for gem stones and for stones of marginal quality for industrial use.

Assuming continuing production at the current rate and at full capacity in the Congo Republic, if the U.S. should cease purchasing crushing bort and industrial diamond for stockpiling, the supply of these types would exceed Free World demand by an appreciable amount, and a period of several years might elapse before consumption by industry would close the gap. To protect the producers, consumers, and prices in such a situation, the Central Selling Organization has established a cash reserve of \$56,000,000 and, in addition, has reserves available for purchasing from producers and for holding in inventory.

OUTLOOK FOR THE FUTURE

The outlook for the future is unpredictable, for it depends on the type of government established in Congo Republic, its stability and policies, continued employment of experienced Belgian and Congolese personnel, and uninterrupted transportation of liquid fuels and supplies. If a protracted interruption of production occurs, the effect on consuming industries will be serious, synthetic diamond may capture a portion of the former market for crushing bort, and the demand for industrial diamond will be very great in relation to supply, a situation that can be expected to lead to an increase in prices which will encourage increase in production in other countries. For the benefit of everyone, but particularly for the residents of the country, it is hoped that a sound and stable government is established without further delay.



COMPUTER METHOD FOR ESTIMATING . . .

PROPER MACHINERY MASS

Strip mining in the domestic coal industry is contributing a greater proportion of overall production than at any time in the past. U.S. Bureau of Mines statistics show that the percentage of total production mined in 1958 by stripping methods increased to more than 30 pct, up from 22 pct in 1951. The tendency to favor strip and open pit mining exists in other mining activities, but such trends are not as clearly outlined as in the coal industry.

Significantly, the depth of overburden in coal properties considered suitable for stripping is also increasing. A depth of 50 to 60 ft of overburden was once considered to be about the maximum amount that could be handled economically. Today, a depth of 80 to 100 ft is frequently taken into consideration for simple overcasting operations (i.e., excavating

overburden and dumping it in the spoil position where it remains indefinitely).

Accompanying these changes, there have been continuing studies searching for procedures to appraise deeper stripping problems. Although the only known practicable way to accurately evaluate a proposed stripping venture is to make studies (including cost estimates) step by step, it is nevertheless desirable to have a quick method for making preliminary evaluations of potential strip mining operations. A recently devised digital computer method of providing a preliminary simple overcasting analysis for a stripping prospect relates the indicated trends in the relationship of the weight of the machine to its ability to do stripping work. In addition, this approach employs situations where the geometry of each cut-and-spoil section is assumed to take certain defined relationships for varying overburden depths. Slopes are necessarily considered to be stable,

H. RUMFELT, Member of SME, is Application Engineer, Bucyrus-Erie Co., South Milwaukee, Wis.



FOR STRIPPING OVERBURDEN

by HENRY RUMFELT

which means such practical factors as the mechanics of soils are neglected for the sake of convenience.

Definition of Terms: The photographs on this and the opposite page show a shovel-type and a dragline-type of simple overcast operation, plus terms used to denote certain parts of a pit. Pits that follow a straight line when projected on a horizontal plane are referred to as *straightaway*. It has been assumed that all section drawings accompanying this article pertain to straightaway cuts which, in turn, means that areas can be compared by relative volume. The volume of overburden is measured in *virgin cubic yards*. Material displaced from its virgin state to a spoil area normally occupies a larger volume than when in situ; the difference is termed *swell*, and it is expressed as a percentage of the original volume. For example, if the original cut volume is denoted V cu yd, and the spoil volume is $1.2 V$ cu yd, the swell is a positive 20 pct.

MAXIMUM USEFULNESS FACTOR (MUF) CONCEPT

Men experienced in overburden removal give emphasis to the weight of the machine in relation to its *value* as an excavator. From the writer's understanding, *value* has been only loosely defined and discussed generally and vaguely. The concept is considered important, however, since it is based upon the observations of many men. It provides a clue for the approach taken to solve deep stripping problems. In the procedure described below, *value* has been arbitrarily established as the product of the nominal dipper size of the shovel (or dragline) times a functional dumping reach.

MUFs—Shovel: A shovel's capability to handle thick overburden is usually limited by its ability to dispose of the spoil. Thus the dumping reach, as well as its dumping height, is significant. The angle of repose of spoil material must also be considered. Al-

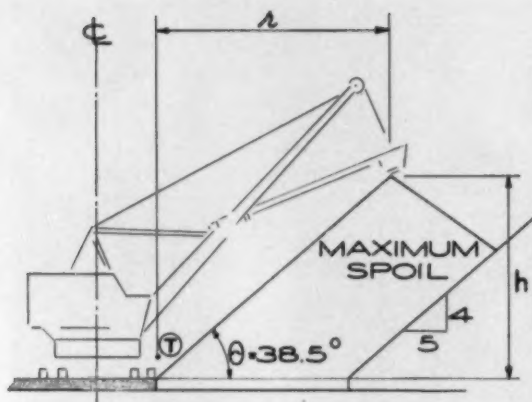


Fig. 1. Shovel Reach Diagram.

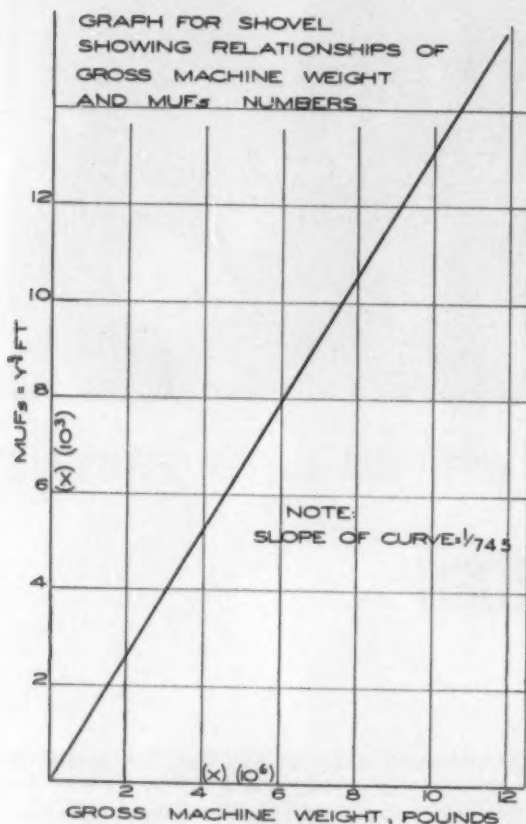


Fig. 2.

though such slope angles vary among different mines, jobs, and materials, a slope of 1.25 to 1, frequently found in both planning and practice, is used by this author in the illustration of this analytical method.

The relationship of the shovel's geometry to a stripping operation is shown in Fig. 1. To gain maximum advantage in constructing spoil piles, the shovel is placed so that its tracks adjacent to the spoil are as close as possible to the rib of the coal deposit. A vertical plane passing through the line of the rib of the deposit would contain the point *T*. By measuring horizontally from *T* to the point of discharge of the dipper, the dumping reach *r* is established

for each shovel analyzed. The "maximum usefulness factor" for a shovel (MUFs) is defined as "the product of the nominal dipper size (measured in cubic yards) times the dumping reach *r* (measured in feet)." In other words, MUFs is equal to the load moment about point *T* in terms of "cubic yards times feet." Table I shows the results of such computations for different shovels studied together with Gross Machine Weights (GMW).

Fig. 2 depicts a trend in GMW of shovels. It is significant that the curve appears to follow a generally straight line regardless of manufacture or size range of machines. According to this curve, each MUFs unit requires 745-lb gross weight in the shovel. In determining this curve, it was found that the points representing existing shovels were more faithful to the trend line (i.e., less "scatter") than shovels existing only on paper. Consequently, all points for existing machines were given greater "weight" by the author than those models in the planning stage. For this reason, the curve was not determined by strict use of the method of least squares.

MUFd—Draglines: As with the shovel, the dragline's ability to handle deep overburden is also normally limited by its ability to dispose of the spoil. Because this machine normally works from the surface of a cut or from a bench floor slightly below the surrounding land surface, its dumping height is not an influencing factor. For the type of operation visualized the dumping reach *r* (Fig. 3) is the controlling factor.

Walking draglines are mounted on circular bases, called "tubs", with different models having different ground-to-base bearing pressures. To have a standardized basis for comparison, the tub diameters on all models of draglines analyzed have been adjusted so that bearing pressures are uniformly maintained at 10 psi.

With the hypothetical diameter of the tubs, plus a 5-ft safety margin between the top edge of the old high wall and the closest point of the tub, a moment center *T* is established. Measuring from *T* to the dumping point gives a moment arm *r* for each dragline considered.

In addition, the author has arbitrarily selected 4750 lb per nominal dragline bucket size to represent the unit weight of bucket plus load contents. The specified suspended load of the machine is divided by 4750 to give the nominal cu yd bucket capacity. This capacity multiplied by the arm *r* (distance in feet) determines the maximum usefulness factor for each dragline (MUFd). Thus, MUFd is defined as the product of the nominal bucket size capacity and the dumping reach of the dragline. It is equal to the load moment about *T* in terms of cubic yards times feet.

Table I. Summary Tabulation of Shovel Data

Shovel Code Designation	Working Weight, lbs	MUFs, cu yd-ft
a	1,785,000	3,156
b	2,030,000	1,740
c	3,070,000	3,938
d	3,345,000	4,350
e	4,950,000	6,734
f	5,790,000	7,630
g	6,060,000	8,264
h	6,555,000	8,580
i	7,700,000	9,900
j	7,875,000	11,720
k	8,585,000	—
l	11,600,000	15,419
m	13,900,000	20,102

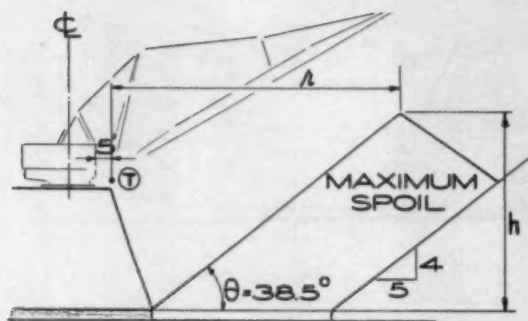


Fig. 3. Dragline Reach Diagram.

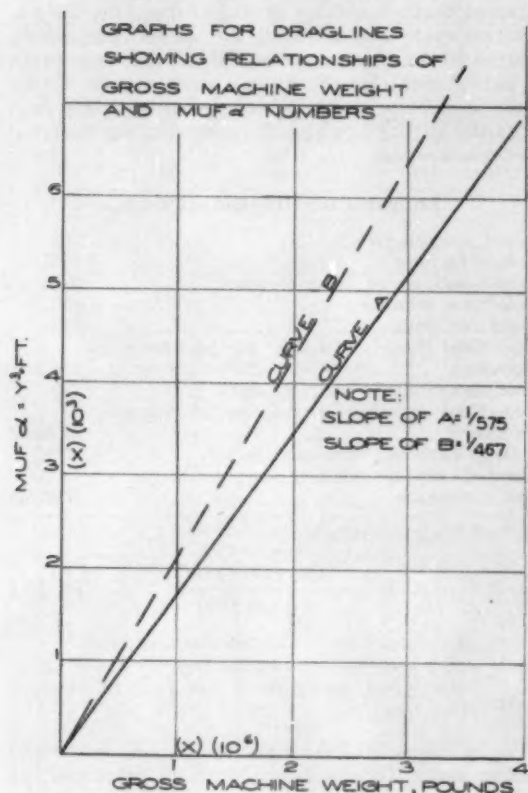


Fig. 4.

Tabulations of MUFd for various electric-powered draglines analyzed are shown in Table I.

In Fig. 4, curve A represents the trend in gross machine weight of existing draglines from major manufacturers. As was true with the operating shovel data, the data of existing dragline models follow this trend line closely. However, curve B represents a trend which could possibly become significant from newer and larger draglines, rather than curve A. Curve B is based on specifications of larger machines recently announced as well as some "up-rated" draglines. The slope of curve A is 1/575, which means that 575 lb of gross machine weight are required for each MUFd. Similarly, the slope of curve B is 1/467 which indicates 467 lb of gross machine weight is necessary for each MUFd.

MUF—PIT SECTION RELATIONSHIPS

In addition to the relationships existing between maximum usefulness factors (MUF) and gross

weights of the machines analyzed, it is also necessary to determine a relationship between the geometry of the pit section and the required MUF numbers for varying depths of overburden. Such numbers would be related, in turn, to projected machine gross weights which, in effect, establishes a relationship between stripping machinery mass and overburden volumes (or depths). Therefore, those mentioned in this section (MUF-Pit Section Relationships) are the required MUF numbers for the hypothetical study below.

Determination of Shovel Reach: In order to determine a relationship between the MUFs numbers of the required machines for different depths of overburden, hypothetical situations with various assumptions are considered. From Fig. 5 a generalized formula to give dimension r can be derived. First, assume the deposit is bituminous coal of thickness t ft and with a cut width of W ft. The spoil angle of repose is 38.5° (1.25 to 1 slope). The berm width b is assumed to be sufficiently small so as not to affect the shovel excavation at its indicated position, and hence, it is not considered in the following formula. It has also been assumed that the slope of the high wall has a ratio of 1:3. (The derivation of this formula and subsequent formulas may be found in the appendix).

The resulting formula is

$$r = (1.25) \left[\left(1 + \frac{S}{100} \right) (H) - t + \frac{W}{5} \right] \quad [1]$$

where r = reach (ft)

S = swell (pct)

H = overburden depth (ft)

W = cut width (ft)

t = deposit thickness (ft)

Selection of Nominal Shovel Dipper Size: To facilitate dipper-size computations, those factors which can usually be closely approximated for a given prospect once the type of machine is selected and a general operating approach determined are assumed to be constant. In the following example of estimating shovel output, it has been assumed that, regardless of shovel size, the average digging cycle will be 56 sec, the dipper load will always be 80 pct of capacity, and the monthly operating factor will be 85 pct of total time. With these assumptions, the fol-

Table II. Summary Tabulation of Dragline Data

Dragline Code Designation	Working Weight, lbs	MUFd, cu yd-ft
a	375,000	587
b	450,000	760
c	550,000	835
d	640,000	1,240
e	695,000	1,080
f	840,000	1,370
g	1,274,000	2,080
h	1,299,000	1,970
i	1,480,000	3,680
j	1,467,000	2,560
k	1,600,000	2,810
l	1,750,000	4,330
m	1,900,000	3,100
n	1,965,000	3,440
o	2,460,000	4,410
p	2,650,000	4,130
q	2,930,000	5,120
r	3,050,000	6,240
s	3,175,000	6,320
t	3,200,000	7,110
u	3,335,000	6,500
v	3,730,000	7,640

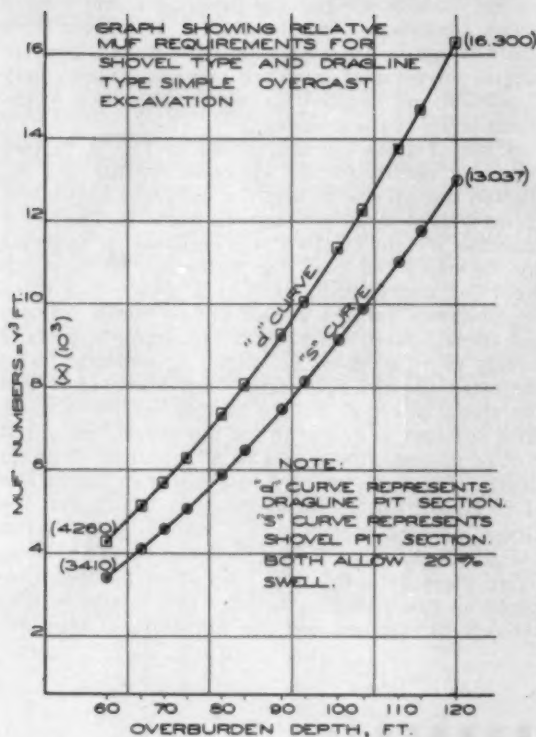


Fig. 7.

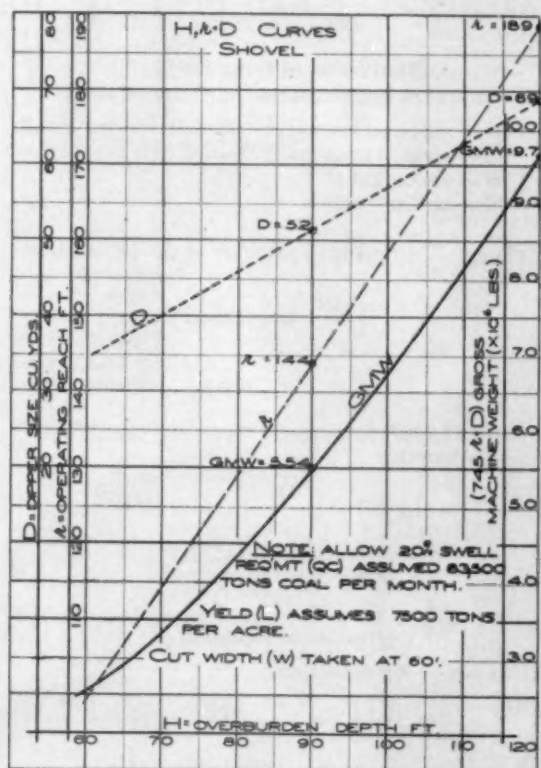


Fig. 8.

per acre. The spoil angle of repose is 38.5° from the horizontal. If mined with a dragline, the cut widths (W), would be 80 ft; if mined with a shovel, the cut widths would be 60-ft wide. The average production rate anticipated is 83,500 (Q_c) net tons of cleaned coal per month. The overburden depths (H) vary from 60 to 120 ft.

Several other involved aspects of the problem make it desirable to know the approximate specifications of shovels required for different overburden depths, as well as the relative MUF requirements of shovels and draglines for the same overburden depths. Furthermore, at the site under consideration, swell (S) is expected to be 20 pct, but it is desired to know the effect if swell should be 25 pct, 30 pct, or 35 pct.

SOLVING PROBLEM BY COMPUTER ANALYSIS

To facilitate the computations of this example, appropriate conversions of variable factors to constant factors were made in the formulas, and a digital computer containing the following programs was employed:

Program A

Equation [1] which gives the reach requirement (r) for the shovel section was solved for different overburden depths (H) from 60 to 120 ft in increments of 2 ft in four separate groups:
 First group; swell (S) = 20 pct
 Second group; swell (S) = 25 pct
 Third group; swell (S) = 30 pct
 Fourth group; swell (S) = 35 pct

Program B

Equation [2] which gives the dipper size requirement (D) for the shovel section is solved for different overburden depths (H) from 60 to 120 ft in increments of 2 ft.

Program C

Equation [3] which gives the MUFs numbers [a product of equation (A) and equation (B)] for the shovel section is solved for different overburden depths (H) from 60 to 120 ft in increments of 2 ft in four separate groups:
 First group; swell (S) = 20 pct
 Second group; swell (S) = 25 pct
 Third group; swell (S) = 30 pct
 Fourth group; swell (S) = 35 pct

Program D

Equation [4] which gives the reach requirement (r) for the dragline section for different overburden depths (H) from 60 to 120 ft in increments of 2 ft in four groups:
 First group; swell (S) = 20 pct
 Second group; swell (S) = 25 pct
 Third group; swell (S) = 30 pct
 Fourth group; swell (S) = 35 pct

Program E

Equation [5] which gives the bucket requirement (B) for the dragline section is solved for different overburden depths from 60 to 120 ft in increments of 2 ft.

Program F

Equation [6] which gives the MUFd numbers [a product of equations (D) and (E)] for the dragline section is solved for different overburden depths (H) from 60 to 120 ft in increments of 2 ft in four separate groups:
 First group; swell (S) = 20 pct
 Second group; swell (S) = 25 pct
 Third group; swell (S) = 30 pct
 Fourth group; swell (S) = 35 pct

PRELIMINARY ANALYSIS OF STRIPPING REQUIREMENTS

The actual results from the computer indicate that percentage variations in the required operation reach r for different swell percentages are substantially uniform for each machine at all overburden depths. For example, at all intervals between 60 ft and 120 ft overburden thickness, the 25 pct swell group necessitates a 4 pct greater reach for a shovel than that required for a 20 pct swell; the 30 pct swell group shows a 7.5 pct greater reach required; and if the swell is 35 pct, the shovel must have an 11 pct greater reach than if the swell were 20 pct. Similarly, the dragline results indicated a 3.5 pct greater reach required for the 25 pct swell group than at 20 pct swell; 6.5 pct greater reach if swell is 30 pct; and 9.5 pct increase in reach for the 35 pct swell group than for the 20 pct swell group.

Another significant finding encountered in this analysis was the uniform relationship which exists between the MUFs curve and the MUFd curve, shown in Fig. 7. The dragline usefulness numbers (MUFd) are approximately 1.25 times greater than the shovel usefulness number (MUFs) at corresponding overburden depths when each series is analyzed on the basis of 20 pct swell. If compared solely

on the basis of weight, the dragline would have a slight advantage over the shovel. However, since this advantage was so small, other factors such as capital investment required became increasingly important and negated further consideration of the possible use of the dragline.

A set of three curves, shown in Fig. 8, related computer results for the indicated reach r , the indicated dipper size D , and the indicated Gross Machine Weight to the overburden depth H . The Gross Machine Weight (GMW) was obtained by applying the factor of 745 (see Fig. 2) to the MUFs result from the digital computer. At a glance, the three requirements for the shovel can be found for any one specific overburden depth. For example, when H equals 90 ft, a 52-cu yd dipper is indicated. Also indicated are the operating reach r of 144 ft and the Gross Machine Weight of 5.54 million pounds. At a 65¢-unit price per lb for the shovel, the initial cost of the machine would be \$3.6 million. With an overburden depth of 120 ft, the indicated dipper size is 69 cu yd, the operating reach is 189 ft, and the Gross Machine Weight is 9.70 million pounds. The cost of the shovel at 65¢ per lb would be \$6.3 million. From these data, together with other pertinent aspects, an optimum overburden depth would be tentatively determined and the conventional type de-

Derivation of Equation [1]

(Refer to Fig. 5)

Let t = deposit thickness (ft)

W = width of cut (ft)

h = height of spoil above datum level (ft)

 r = reach (ft) as measured from T H = cut height (ft)
$$A_s = \text{spoil area (sq ft)}$$

Ac = cut area (sq ft)

S = swell (pct)

$$As = (t)(W) + \left(h - \frac{W}{25}\right)(W) + \left(\frac{W}{25}\right)\left(\frac{W}{2}\right)$$

Therefore,

$$As = (t)(W) + hW - \frac{W^2}{5} \quad (a)$$

$$Ac = (W)(H) \quad (b)$$

Therefore,

$$As = \left(1 + \frac{S}{100}\right)(Ac)$$

$$As = \left(1 + \frac{S}{100}\right) (W) (H) \quad (c)$$

Combining equations (a), (b), and (c)

$$\left(1 + \frac{S}{100}\right)(W)(H) = (t)(W) + (h)(W) - \left(\frac{W^2}{5}\right)$$

$$\left(1 + \frac{S}{100}\right)(H) = (t) + (h) - \left(\frac{W}{5}\right)$$

$$(h) = \left(1 + \frac{S}{100}\right)(H) - (t) + \left(\frac{W}{5}\right)$$

Since $r = 1.25h$,

$$\tau = (1.25) \left[\left(1 + \frac{S}{100} \right) (H) - (t) + \left(\frac{W}{5} \right) \right] \quad [1]$$

Derivation of Equation [2]

(Refer to Estimated Shovel Output Table)

Let Q_c = required net tons of cleaned coal per month

L = yield in net tons of cleaned coal per acre

H = cut height (ft)

4840 = sq ft per acre

Thus, $\left(\frac{H}{3}\right) (4840) = 1613(H) = \text{cu yd of overburden per acre.}$

$$\left(\frac{Qc}{L}\right) (1613) (H) = \text{cu yd of required stripping per month.}$$

Since 31,200D also equals cu yd of required stripping per month:

$$31,200D = \left(\frac{Q_c}{L} \right) (1613) (H)$$

$$D = \frac{(Q_c)(1613)(H)}{(L)(31,200)} \quad [2]$$

Derivation of Equation [3]

$\text{MUF}_s = r \cdot D$, by definition

$$\text{MUFs} = \left\{ (1.25) \left[\left(1 + \frac{S}{100} \right) (H) - (t) + \left(\frac{W}{5} \right) \right] \right\} \times \left\{ \frac{(Qc) (1613) (H)}{(L) (31.200)} \right\} \quad [3]$$

tailed stripping analysis, including cost estimates, undertaken.

CONCLUSIONS

The true value of the demonstrated approach to preliminary stripping analysis can be determined only by experience and trial with real problems. It must be emphasized that the aim of this article has been to illustrate an approach for attacking such problems. The examples and assumptions by this author must be considered only as media through which the approach and procedure are demonstrated. They have been deliberately selected to be slightly on the unrealistic side so as to focus attention on the approach and procedure in analyzing such problems.

On the other hand, the work in compiling the MUF trends of shovels and draglines was conducted as accurately as was practicable. It is expected that with present design criteria, shovels of the future will probably follow the demonstrated MUF's trend. Furthermore, it seems possible that draglines will require considerably less operating weight, approximating or even surpassing Curve B. of Fig. 4.

It is felt that this study demonstrates a procedure that can be used to approximate the size machines required for simple overcasting at different overburden depths and defined sets of conditions. These

conditions may be selected arbitrarily, or they may be determined by experience in the particular property or a property similar to the one taken into consideration. With the exception of the output tables, it is expected that in most instances the equations herein derived with the simple type of substitutions shown will suffice for most problems. Conversely, more radical changes of formulas may be required for more unusual problems. A number of changes are possible which will continue to permit equations to be suitable for submission to a digital computer. For example, the angle of spoil repose can be changed, another high wall slope may be assumed, and the construction of output tables may be different, all of which would be included in any new derivation.

It should also be emphasized that this study does not take into account the many variables which are encountered in real stripping problems. The derivations of the formulas and the illustrative example required hypothetical situations. Actually the entire study is based upon situations and trends which are not necessarily fixed. While the trends themselves seem quite clear, there is no proof that they are absolute, and therefore, the study should be accepted with the understanding of the existence of this possible limitation.



Derivation of Equation [4]

(Refer to Fig. 6)

Let t = deposit thickness (ft)

W = cut width (ft)

h = height of spoil above datum level (ft)

r = reach (ft), measured from T

H = cut height (ft)

As = spoil area (sq ft)

Ac = cut area (sq ft)

S = swell (pct)

$$As = (W)(t) + (W)\left(h - \frac{W}{2.5}\right) + (W)\left(\frac{W}{2.5}\right)\left(\frac{1}{2}\right)$$

$$As = W + Wh - \frac{W^2}{5} \quad (d)$$

$$Ac = (W)(H) \quad (e)$$

$$As = \left(1 + \frac{S}{100}\right)(Ac) \quad (f)$$

Combining equations (d), (e), and (f),

$$\left(1 + \frac{S}{100}\right)(W)(H) = (W)(t) + (W)(h) - \frac{W^2}{5}$$

$$\left(1 + \frac{S}{100}\right)(H) = t + h - \frac{W}{5}$$

$$h = \left(1 + \frac{S}{100}\right)(H) - t + \frac{W}{5}$$

$$\text{Since } r = \frac{(H - 10)}{3} + (1.25)(h)$$

$$r = (0.33H - 3.3) +$$

$$\left[(1.25)\left(1 + \frac{S}{100}\right)(H) - t + \frac{W}{5}\right]$$

$$r = (0.33H - 3.3) +$$

$$\left[(1.25)\left(1 + \frac{S}{100}\right)(H) - 1.25t + 1.25\frac{W}{5}\right] \quad [4]$$

Derivation of Equation [5]

(Refer to "Estimated Dragline Output Table")

Let Qc = required net tons of cleaned coal per month

L = net tons of cleaned coal yielded per acre

H = cut height (ft)

4840 = sq yd per acre

$$\left(\frac{H}{3}\right)(4840) = 1613(H) = \text{cu yd of overburden per acre.}$$

$$\left(\frac{Qc}{L}\right)(1613)(H) = \text{cu yd of required stripping per month.}$$

Since 30,400B also equals cu yd of required stripping per month:

$$30,400B = \left(\frac{Qc}{L}\right)(1613)(H)$$

$$B = \frac{(Qc)(1613)(H)}{(L)(30,400)} \quad [5]$$

Derivation of Equation [6]

MUFd = $r \cdot B$, by definition

$$\text{MUFd} = (0.33H - 3.3) + \left[(1.25)\left(1 + \frac{S}{100}\right)(H) - 1.25t + 1.25\left(\frac{W}{5}\right)\right] \left[\frac{(Qc)(1613)(H)}{(L)(30,400)}\right] \quad [6]$$

THE MINE GEOLOGIST

PAST PROBLEMS, PRESENT PURPOSE AT PITCH

by ARTHUR BAKER, III and BILL C. SCOTT

The Pitch mine of Pinnacle Exploration, Inc. is in the Marshall Pass district, thirty miles east of Gunnison, Colorado. This is a new mining district, having come into existence as recently as 1955, when uranium mineralization was discovered rather late in the days of the uranium boom. There have been three other mines in the district, all of them now inactive. Two of these produced a few hundred tons of very high-grade uranium ore, and the third, Pinnacle's Little Indian 36 mine, produced a few thousand tons of lower grade ore.

Pinnacle was one of the first companies in the district, and was able to acquire a large acreage. The first two years of exploration were essentially wasted in looking for Plateau-type deposits in a mineralized sandstone bed, but this "wasted" work produced two specific items that paid off. One was an ore-grade outcrop that ultimately became the Little Indian 36 mine, and the other was a boulder of very high-grade uranium ore that eventually led to the discovery of the Pitch mine; however, the actual source of the boulder still has not been found.

Drilling and shallow underground exploration were started at the Pitch mine late in 1956, and two years later the present main haulage level was started. Production began in the spring of 1959 at a rate of 50 tpd, and is now maintained at about 120 tpd. The grade is variable, but it averages about 0.40 pct U₃O₈. The ore is milled at the Cotter Corp.'s carbonate leach plant in Canon City, Colo.

The Pitch mine has some problems peculiar to itself, but its basic problem is the same as every mine's—how to make as much profit as possible for as long a time as possible. A set of unusual circumstances caused the Pitch mine to go through most of the trials and triumphs in the past two years that a larger mine might go through only in twenty years or more. As such, it provides an excellent nutshell example of the ups-and-downs of a mine—when things were bad, the muckers' children knew it; and when a new orebody was found, it showed up on the

President's monthly profit and loss statement within two or three months.

The purpose here is to outline the part the mine geologist played in the struggle. The main point is that a mine geologist is essential to any mine—when things are good as well as when they are bad. Aside from his value in day-to-day operations, he is ordinarily the only man in the operation whose primary purpose is to find the ore that will keep the mill going during the next ten years—or during the next quarter, as it was at the Pitch. No matter how interested they are in the problem or how clearly they recognize its importance, the Manager, the Mine Superintendent, and the rest of the staff seldom, if ever, have the time to accumulate and study the mass of detailed information available to find the subtle signposts that point to new ore. Only the geologist (or his equivalent, whether he is called "Engineer", "Sampler" or whatever) has the time, and the inclination (if he is a good one) to do this.

PROBLEM AT THE PITCH

The peculiar situation arose out of a geological misinterpretation for which we make no apologies. It was a perfectly good interpretation of the known facts—its only flaw being that it was wrong.

The general geology of the Marshall Pass area is fairly simple. An exposed patch of Paleozoic sediments, several miles in diameter, has a fault contact with Precambrian rocks on the east side, and covered by Tertiary volcanics on the other sides. The sediments are gently folded and well-exposed except along the Chester Fault, which separates them from the Precambrian schists and intrusives on the east side. There, they are strongly drag-folded along the fault, and generally covered with thick soil. The Pitch orebodies are along the Chester Fault in the Belden formation (Pennsylvanian)—a series of carbonaceous shales, sandstones, thin coal beds, and erratically distributed limestone lenses. The fault strikes north and dips essentially vertically, and the beds immediately adjacent to it also strike north and dip vertically.

The first work in the area of the Pitch mine consisted of trenching and driving a short adit along

A. BAKER, III, Member of SME, is Chief Geologist, and B. S. SCOTT is Mine Geologist, Pinnacle Exploration Inc., Salt Lake City, Utah, and Gunnison, Colo.

the fault. Although this work disclosed some small pockets of very high-grade ore, it showed uranium to have been originally more abundant. Most of the uranium had been leached out, leaving behind only highly radioactive daughter products. It also demonstrated that the only strongly-mineralized ground was within or immediately adjacent to the Chester Fault itself—a 2-ft gouge zone.

Fifteen diamond drill holes were drilled along a 2000-ft length of the fault. Some of these missed the fault completely and some were barren, but several had ore intersections. Core recovery was extremely poor, but radiometric probing demonstrated the presence of respectable thicknesses of ore. The little core recovered checked fairly well with the probe results. Strangely, however, the drilling indicated that the Chester Fault, which everywhere on the surface was vertical, changed at a depth of approximately 200 ft to an almost horizontal westward dip—or else was cut off by a flat fault. Neither of these interpretations fitted with the known geology of the district, but it was a new district and we were aware that we didn't know much. At any rate, the positions of the ore encountering drill holes were such that they indicated a horizontal continuous body of ore along the bend in the fault surface—or the intersection with the flat fault—or at least a continuous structure favorable for ore. With this much geologic evidence plus the predictable cost and unsatisfactory results of further drilling, it was decided that the next step should be underground work. On the basis of the drilling results, the Atomic Energy Commission had contracted to buy some 100,000 tons of medium grade ore, so there was a market for production.

The Pitch adit was driven to reach the Chester Fault at a low-grade ore intersection in one of the drill holes. Instead of the narrow low-grade that was expected, 15 ft of high-grade ore was encountered. The ensuing rejoicing was tempered in the next two or three months by the discovery that the length of ore was short and the interpretation of the geology and ore occurrence was entirely wrong. Instead of a neat, well-defined fault 2-ft wide, the Chester Fault is a zone 400-ft wide. At the surface the entire width of the fault zone lies in the Paleozoic sediments, but at the haulage level it is almost all Precambrian rocks (Fig. 1). Between the two elevations, there is a confusing welter of large wedges of sediments separated by similar wedges of Precambrian rocks (Fig. 2). To make matters worse, almost all of the rocks in the zone were incompetent to start with, and the shearing they have been subjected to made them even more incompetent. As such, the ground is very bad for permanent openings, but good for stopping purposes.

The Pitch orebodies, as we now know them, are lenses within limestone wedges. The lenses contain from 2,000 tons to 60,000 tons of ore, and perhaps more (Fig. 3). Since the limestone blocks are fault slivers, they are erratically distributed although oriented roughly parallel to the overall trend of the fault zone. There is no way of predicting where they might occur, but once a limestone block has been found, the odds are good that an orebody is in it somewhere—probably where it is in fault contact with Precambrian rocks. Unfortunately the Precambrian rocks are as erratically distributed as the limestones. The best guide to ore is mineralization itself—the orebodies ordinarily tail out along



Incompetent, sheared rock at Pitch is just one problem. This timber set failed only 15 ft from a working face.

the strike and dip into narrow low-grade zones, which provide a larger target than the orebodies alone. All of the narrow low-grade exposures explored to date have proven to be associated with ore-grade bodies, though some of the bodies are too small to be worth developing. Except for very rare sulfides, the only mineral associated with the mineralization is the pitch-blende itself, and even in the highest grade ore there is not much of that. Therefore, it is almost impossible to visually distinguish between ore and waste.

It is apparent that the basic problem at the Pitch mine was simply to keep it alive. This could be done only by finding erratically distributed orebodies in an unbelievably complex fault zone—like picking plums out of a pudding. Like plums, the orebodies have no pattern of occurrence, and much of the ground is of about the same consistency as a stiff pudding. Much of the incentive for keeping the mine alive lay in two "plums" 1,000 ft south of the Pitch adit. These were two long high-grade drill hole intersections in which the geologists had much faith. These have been reached in the past few months, and proved to be well worth the trouble.

USE OF GEOLOGY

Because of the bad ground and small size of the orebodies, it was economically impossible to explore the fault zone by crosscutting. The final plan was to drift toward the south drill hole intersections and drill fans of percussion longholes at 50-ft intervals along this drift. With some modifications, this has worked out well. Except for some 300 ft of drift and raise abandoned because of bad ground, all head-

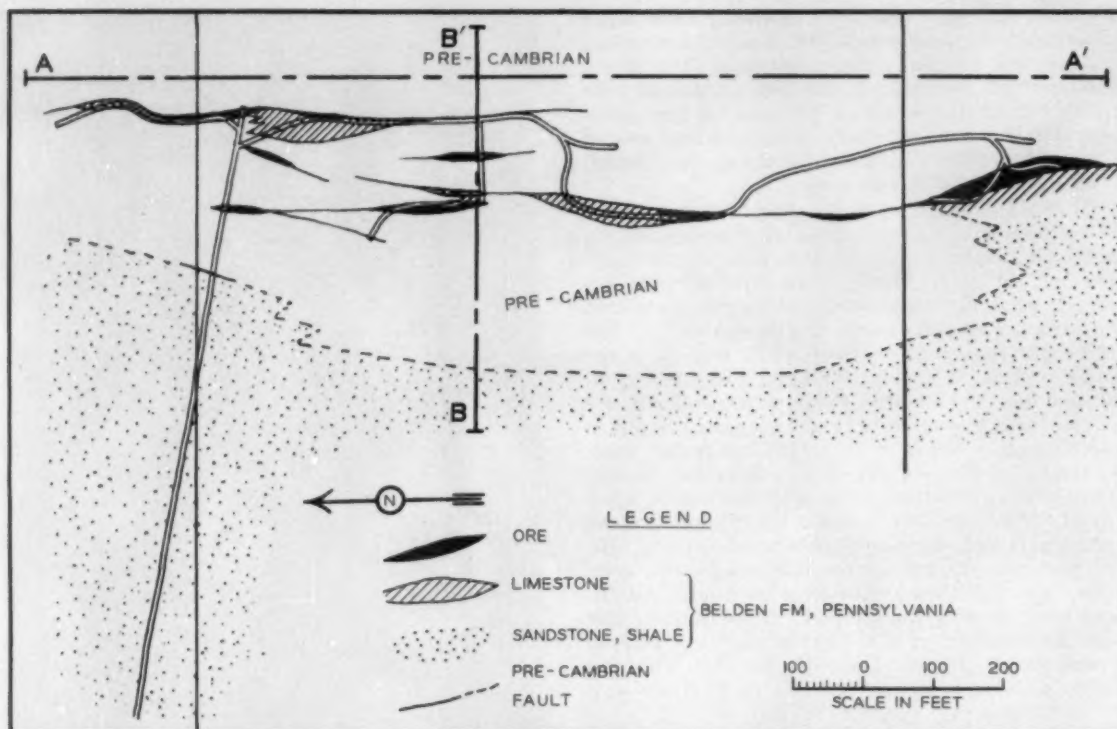


Fig. 1. Pitch Level, generalized geologic plan.

ings have paid for themselves as production openings. It was found necessary to drill longholes from all available openings, as well as the main haulage drift—particularly from raises and stopes, to explore upper ground not reachable from the level—and instead of fans, many of the drill setups ended up looking more like pincushions, with holes in all directions. It was also found that there was extreme dilution of the longhole cuttings. Now, the driller's log of the hole, based on the way the ground drills, is frequently given more weight than the geological log of the cuttings; in particular, very bad drilling is considered a fair indication of ore, even if none shows up in the cuttings. All holes are probed radiometrically, if possible, but even with increased experience the drillers are not always able to keep the holes open long enough to permit probing.

In this kind of exploration, the part of the mine geologist is two-fold. Officially, his job is to try to keep development headings in reasonably good ground, to lay out preliminary longholing patterns, log and interpret the cuttings and the probe records, and lay out further longholing aimed at the best targets for ore. The secondary purpose of the geologist (unofficial but fully as important) is to keep "pushing" all personnel to get the drilling done. This was not always an easy task when there were only two stopes to provide the week's muck, and a few longholes would close down one of them for three or four shifts. Experience soon demonstrated, however, that longholing was the only hope for the operation and is now tolerated, if not welcomed, even when it must interfere with production.

The Pitch mine is a well-organized and staffed operation, and any of the staff members can handle many of the jobs of the other members. Thanks to this, the mine geologist spends less than half of his

time underground; the engineer or the mine superintendent handles most of the longholing supervision, leaving the geologist free for more specialized work. His underground work consists largely of mapping development headings and twice or thrice-weekly visits to all of the stopes, which are not ordinarily mapped. He also logs all drill cuttings, a task that requires a geologist because, with the excessive dilution, sometimes a few chips of limestone in a sack of schist cuttings are the only indication of a significant intersection.

The biggest part of the geologist's time is spent in the office. Some of this is more or less wasted time—writing the reports that every head office wants, and perhaps reads—but most of it is productive work even though it may not look so at the moment. One of the chores, distasteful to most geologists but necessary and eventually productive, is getting maps, logs, probe records, and other basic information into preservable shape so that they will be useable in future years. However, the part that pays off the investment in the geologist is his analysis of the information which he has gathered underground. This starts with maps of the workings and sections through longhole fans, and progresses through the drawing in obvious contacts, to pondering about why limestone chips showed up in the cuttings from a hole, or why the probe record of another hole shows a little bump at 87 ft. It ends up ordinarily with much staring into space and an occasional lightly sketched line on the sections, followed perhaps by agonized pleading for "just three more holes before blasting down the stope."

CONCLUSIONS

We do not mean to imply that the geologist does all of the ore-finding thinking at Pitch. He does the greatest part of it, surely, but the rest of the staff

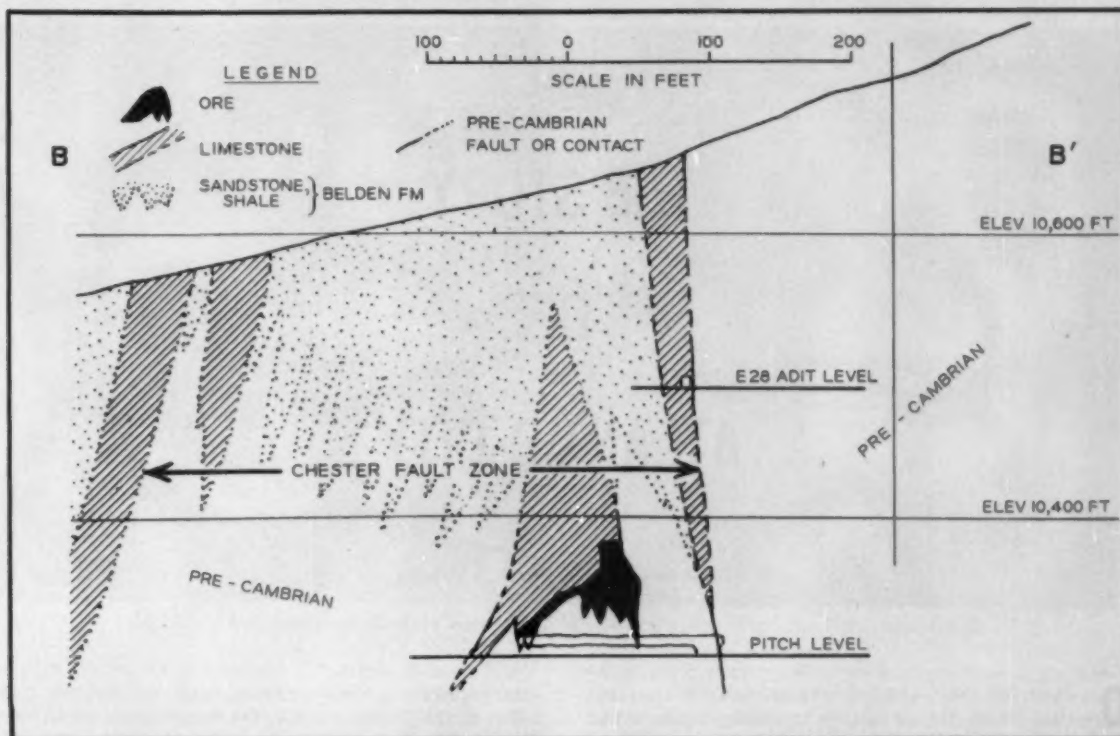


Fig. 2. Cross Section B-B', through Chester Fault Zone, showing localization of ore in limestone wedges.

drops in frequently to study the maps and sections and argue their own interpretations. A good many longholes have been aimed by others of the staff, either surreptitiously or after argument, and more than one of these have yielded vital information. Regardless of who aims the holes, however, the geologist is the only one who has the time to gather the basic information and compile it into the useable maps and sections without which none of the staff could form more than hazy ideas as to targets.

Unfortunately, we are unable to point to any individual orebody and say, "mine geology found

this." Geology is just one of many tools, none of which is indispensable in finding ore; it might be considered as one of a list of indispensables, along with money, management, and long-holing. Without the other three, the mine would have had to be abandoned after the original orebody was worked out; but without mine geology to direct them, probably half of the ore that has been mined to date would not have been found. As a result, the effort might well have been abandoned before the southern drill hole intersections (which now assure a profitable operation) could be explored.

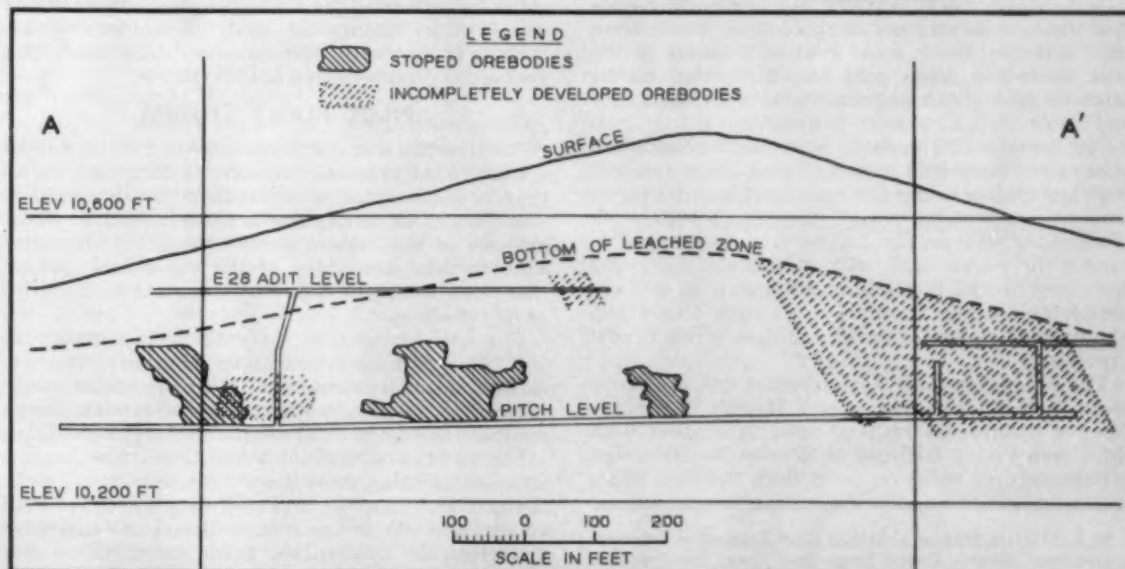


Fig. 3. Longitudinal Projection A-A', showing distribution of orebodies along explored part of Chester Fault Zone.

THE STORY OF ATLANTIC CITY

Based on a report by W. F. PRUDEN

On June 30, 1960, ground was broken for the construction of the facilities to mine, concentrate, and agglomerate the iron ores of the Atlantic City, Wyo., area which has become known as the "Atlantic City Project." This was a historic occasion for Columbia-Geneva Steel Division of United States Steel Corp. When completed, the installation will be the first integrated iron ore beneficiation plant west of the Mississippi River producing an agglomerated product.

This Project, named for a nearby ghost mining town, is located in central Wyoming on the southeast flank of the Wind River Mountains. It is 16 miles north of the South Pass, where the early pioneers who followed the Mormon and Oregon Trails crossed the Continental Divide. White men first penetrated into this area in October, 1812, when Robert Stuart Party brought the returning Astorians through South Pass on route to St. Louis from the Columbia River area. Further interest in the area developed when gold was discovered in the sands of Rock Creek and the towns of Atlantic City and South Pass City were founded.

The Atlantic City orebody is about 28 miles south of Lander, Wyo. It is expected that the employees required for operating the new facility will live in Lander, which at the present time has a population in excess of 4000 people. Lander is well equipped to handle the people who will operate the mine and associated works for Columbia-Geneva. It has recently built a new hospital and a high school and has made plans for the healthy growth which is now expected.

The beneficiated and agglomerated ore will move south from Atlantic City over a 76-mile Columbia-Geneva constructed railroad spur to connect with the Union Pacific Railroad at Winton Junction, approximately 10 miles north of Rock Springs. From

this connection, the product will be hauled 279 miles to the Columbia-Geneva blast furnaces at the Geneva Works in Provo, Utah, by the Union Pacific Railroad.

The Atlantic City orebody is a metamorphosed Precambrian sediment. The iron formation lies in a series of sericite, chlorite, garnet, and staurolite schists with abundant greenstones. All of the metamorphic rocks are intruded by small diorite dikes and sill-like bodies. Gently folded, east-dipping Paleozoic sandstones and limestones cover the Precambrian rocks about one mile east of the exposed orebody. The deposit, which outcrops along a hill, trends northeasterly and dips about 85° to the east. In the deepest drilling to date, termination of the ore zone at depth has not yet been determined.

The long-range mining plan as developed provides for removing the ore by conventional methods using truck haulage on 25-ft levels with 37½-ft wide safety berms left on every third level. The average overall pit slope will be 45°.

PILOT PLANT STUDIES

Because the iron formation at Atlantic City is so similar to the magnetic taconites in Minnesota in its type and character of mineralization (practically, it is difficult to distinguish it from the Upper Slaty member of the Eastern Mesabi Range) it was possible to take advantage of the experience gained there in translating drill core test data to the projected practice.

The core composites were all tested using the U.S. Steel's Oliver Iron Mining Division's standard methods for determination of Magnetic Iron content. In addition, representative composites were tested for their ability to be ground and concentrated.

Fig. 1, a typical concentration curve, indicates the effect of grinding upon the weight recovery of concentrate and upon the iron and silica content of that concentrate. As is common with typical magnetic taconites, the concentrate grade improves as the material is ground finer: for example, at a grind of 70 pct minus 270 mesh, the iron in the concentrate

W. F. PRUDEN, Member of SME, is Chief Engineer of Columbia-Geneva Steel Division, United States Steel Corp., San Francisco, Calif. This paper was presented at the 1961 AIME Southwest Minerals Industry Conference by S. H. COHLMAYER, Project Manager.



Model of the proposed plant to be erected in Atlantic City, Wyo. by U.S. Steel Corp.

is 61.5 pct; at 90 pct minus 270 mesh, it is 65.5 pct iron. Under the same conditions, the silica is lowered from 12 pct to 9 pct with a corresponding reduction in the weight recovery from 39 pct to 35 pct.

As testing progressed it became readily apparent that in the upper portion of the orebody, and especially on the Eastern Slope, there was a definite halo of partial surface oxidation, believed to be the result of melting snow from heavy drifts. Consequently, the ore was divided into two classes—prime and oxidized. Prime ore was defined as material having a concentration ratio of less than 3:1 and a total recovery of more than 75 pct. Oxidized ore was defined as material having a concentration ratio of more than 3:1 and a total iron recovery of less than 75 pct. Iron formation having a concentration ratio greater than 5:1 is considered waste.

As a result of these studies, and because the upper ore must of necessity be taken first, the mining plan was divided into two phases wherein the major portion of the oxidized ore will be mined during the first six years of operation and the prime ore will be mined thereafter.

Late in 1956, preliminary engineering was started and it was decided to obtain a representative bulk sample of the orebody of sufficient size for full scale pilot plant testing. Consequently, 3000 tons of ore were taken from a 728-ft adit which was driven across the orebody. This ore was shipped to the Pilotac plant of the Oliver Iron Mining Division at Mountain Iron, Minn. For control purposes, the ore was divided into two lots of 1500 tons each to check variations in ore types.

On the basis of the tests performed on the drill core composites, it was believed that a typical Minnesota taconite crushing and grinding flow sheet could be employed. Hence, this ore was crushed, ground, and concentrated at Pilotac in May, 1957, using commercial size equipment. As the result of this test, it was possible to obtain the data needed to firm up the design factors, and at the same time, assure management that the iron and silica content of the final shipped product would be as indicated by the ore concentration tests on the drill cores. The

concentrate produced in these tests was agglomerated by several different methods, and further testing of the agglomerates was completed in a pilot plant blast furnace.

Upon completion of the full scale pilot plant tests, data was available to:

- 1) Develop the mining plan.
- 2) Determine the number of crushing stages required.
- 3) Fix the desired mesh-of-grind and determine the number of grinding steps and the types and sizes of mills required.
- 4) Outline magnetic concentrating and filtering characteristics and the equipment required.
- 5) Assist in the selection of the agglomerating method to be used.

ENVIRONMENTAL INFLUENCES ON ORE PROCESSING

In addition to the many characteristics of the ore and its processing, there were several location and climate considerations which had a definite influence upon layout, design, and methods used in handling the iron ore.

Weather Supply: The weather at Atlantic City is similar to that encountered in northern Minnesota, except for precipitation; hence, it was apparent that

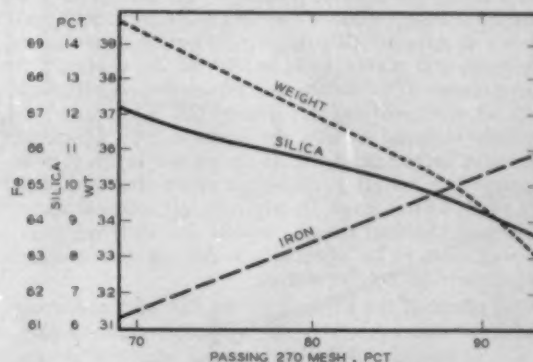


Fig. 1. Concentration curve of Atlantic City ore.

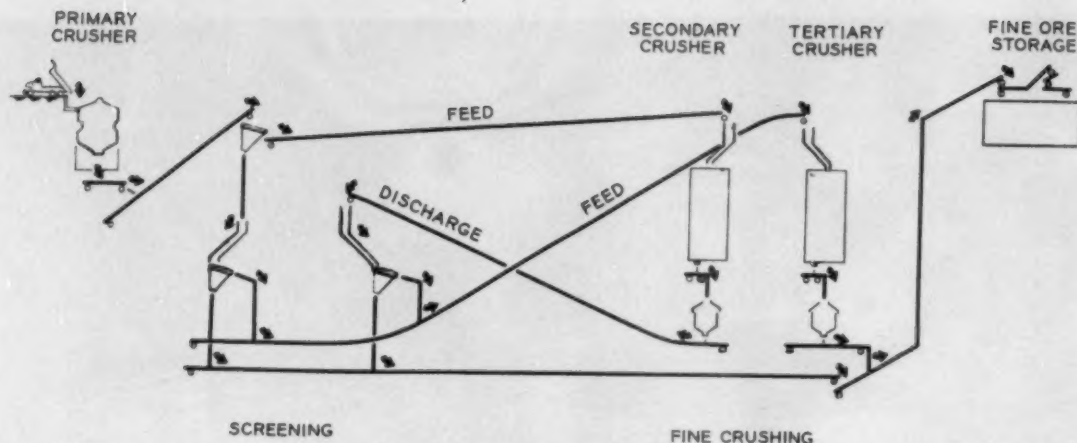


Fig. 2. Flowsheet of crushing plant.

one could expect hard freezing conditions from November to May. Because of the necessity to reclaim and re-use all water possible, and the known deleterious effects of the calcium ion on the balling characteristics of concentrates, the addition of calcium chloride to the ore to inhibit freezing had to be ruled out. To assist the prevention of frozen ore in crushing plant bins, the final crushing flowsheet and layout provides for the removal of all ore fines as soon as they are made. These are added back to the crushed ore prior to storage ahead of the primary grinding mills.

Water Supply: Water is, of course, a major factor of concern to all ore dressing operations, and in this arid section of the West, it is of particular importance. As such, the use of fresh water must be maintained at a minimum, and complete facilities installed to recover used process water to the maximum extent possible.

Water runoff data for Rock Creek, the principal source of water, indicated that 50 pct of the available water is produced from melting snow that runs off during May. In order to supply the plant with fresh water and process make-up water (which will average about 2000 gpm), a 2800 acre-ft reservoir was designed to impound this water during the spring runoff for use during the remainder of the year. Such a storage would have sufficiency in the worst three-year drought cycle recorded during the past 50 years.

Altitude: The plant is located at an average elevation of 8300 ft above sea level. This, of course, introduces many processing problems. The effect of this altitude is better understood when one considers that the air at Atlantic City is only 75 pct as dense as at sea level and water boils at 196°F. As a result, it was necessary to derate all air-cooled equipment, such as electrical motors. Since the maximum attainable vacuum at this elevation is only 21 in. of mercury, rather than the 30 in. at sea level, it was necessary to install a filter area twice that required in a plant at sea level. In addition, all internal combustion equipment such as trucks and railroad locomotives had to be specified to deliver the desired horsepower at this elevation.

The effect of the thinner air on the agglomerating operation was especially acute, and it made it necessary to increase the length of the machine by approximately 15 pct and increase the fan sizes by 20

pct. Since additional energy is consumed by these modifications, the kw-hr requirements per ton of product had to be appropriately adjusted over the amount used in a sea level plant.

Snow: Considerable wind and drifting snow are the normal winter conditions at Atlantic City; consequently, all buildings were designed with flat roofs and aligned with the prevailing wind to assist in self-cleaning and the prevention of build-ups of snow and ice and the safety hazards that result from slides. Precast concrete panels are installed along the lower 6 ft on the side of all buildings as protection to the sandwich siding from snow removal equipment. Much attention has also been given to the prevention of moisture penetration in the outside walls of all buildings.

ATLANTIC CITY FLOW SHEET

Crushing and Grinding: As shown in the schematic flow sheet (Fig. 2), run-of-mine ore will be crushed in a 54-in. gyratory crusher with a closed-side setting of 6 in. This product will be screened into plus 1½-in. and minus 1½-in. fractions. The minus 1½-in. portion will be further screened to remove minus ¾-in. material. The plus 1½-in. portion will be crushed in a second stage in two 7-ft standard cone crushers and then screened to remove the minus ¾-in. material. The plus ¾-in. oversize, combined from the two screens, will be put through the third stage crushers; two 7-ft short head cone crushers whose product will be combined with the fines from the other screening operations and conveyed to the rod mill feed storage bins.

Concentration: The Atlantic City concentrator will consist of three milling circuits operating in parallel. Each circuit will consist of one 10½ x 15-ft rod mill for primary grinding, followed by two 10½ x 15-ft ball mills, with the subsidiary magnetic separators, classification, and filtering units.

In the concentrator (Fig. 3) the ¾-in. ore is ground by the rod mills and then magnetically separated by cobbles. The ball mill grinding is in closed circuit with rougher magnetic separators and cyclone classifiers. After grinding, the pulp is de-slimes and passed through the third stage magnetic separators—the finishers. Thickening and filtering complete the operation.

Pelletizing: Because of the filtering problem at this elevation and the need for uniformity in the

filter cake moisture if good pellets are to result, a system was designed to provide a storage for 36 hours of feed to the pelletizing plant. This storage system (Fig. 4) will stabilize the balling operation and assist in obtaining a uniform product. This plant will have two separate processing units operating in parallel, each with three balling drums and one 6-ft wide, 32-windbox pelletizing machine similar to those in use at Reserve Mining Co.'s plant at Silver Bay, Minn.

After blending, the filter cake will be fed to a balling drum operating in closed circuit with screens. When a green ball is of a sufficient size (approximately $\frac{1}{2}$ in.) it will leave the circuit and pass to the pelletizing machine. On this machine, the green balls will be dried, heated to approximately 2400°F., and then cooled prior to discharge.

POWER SUPPLY

Public utilities in this area were of prime importance in the general plant layout since electrical power and fuel costs are major factors in an operation of this type. Electrical energy will come from the Pacific Power and Light Co.'s new facilities at Glenrock, Wyo. In addition, an emergency diesel-electric generating plant will be maintained at the plant site. This unit is large enough to supply essential services and to allow the equipment handling hot materials, such as the pelletizing fans, to be cooled without harm if the main source of power from the Glenrock area is lost. Natural gas will be supplied by the Northern Mountain Gas Co. of Casper, Wyo., through a pipeline about 25 miles long from the Beaver Field east of Lander.

LAYOUT OF PLANT FACILITIES

In the design of all portions of this project, considerable use has been made of scale models. These were of particular importance in the studies pertaining to the actual operation of the plant. In summary, a model can help in the following ways:

- 1) Permits three dimensional comprehensions of the complexities of the plant that could not be obtained without tedious review of the blueprints.

This is particularly applicable to operations.

- 2) Assists in the study of the problems of maintenance in and around all equipment.

- 3) Provides for a detailed study of the operations and operator locations which could be reviewed on the models and results compared to actual job site studies obtained at the time of design.

- 4) Helps to solve many problems in material flow and equipment design prior to actual startup.

- 5) In addition, the models have been moved to the construction site to assist in scheduling and coordination of that phase of the work. They will also be used to help train operators and finally to explain layouts to visitors.

The model of the plant area (page 493) shows the layout of the principal operating departments. The primary crusher (upper right hand corner of model) is at the center of gravity of the orebody; that is, 50 pct of the ore will be raised by conveyor to the screen house. The ore is conveyed uphill, through the fine crushing plant and into the fine ore storage bins ahead of the rod mills.

The lay of the ground made it possible to locate the concentrator (lower left corner of model) on the side of a hill which will permit gravity flow of ore and pulp through the process. In addition, this plant location will provide for the discharge of tailings (both coarse and fine) directly to the tailings basin. By building a trestle across the tailings basin, fine tailings can be disposed of by gravity for at least 10 years without pumping. The coarse tailings will be transported by truck directly across the plant road into an area with sufficient volume for the life of the property.

The filter cake concentrate will be conveyed to a higher level area which offered the only suitable site for the pelletizing operation and the related loading facilities and railroad yards. Location of this portion of the plant was also influenced by the layout of the railroad and the entrance of the railroad spur to the facility.

A 2 $\frac{1}{2}$ -mile long overflow ditch will extend from the reservoir on Rock Creek to the Slate Creek drainage, which in turn will return the water to Rock Creek. Fresh water for the plant will flow by

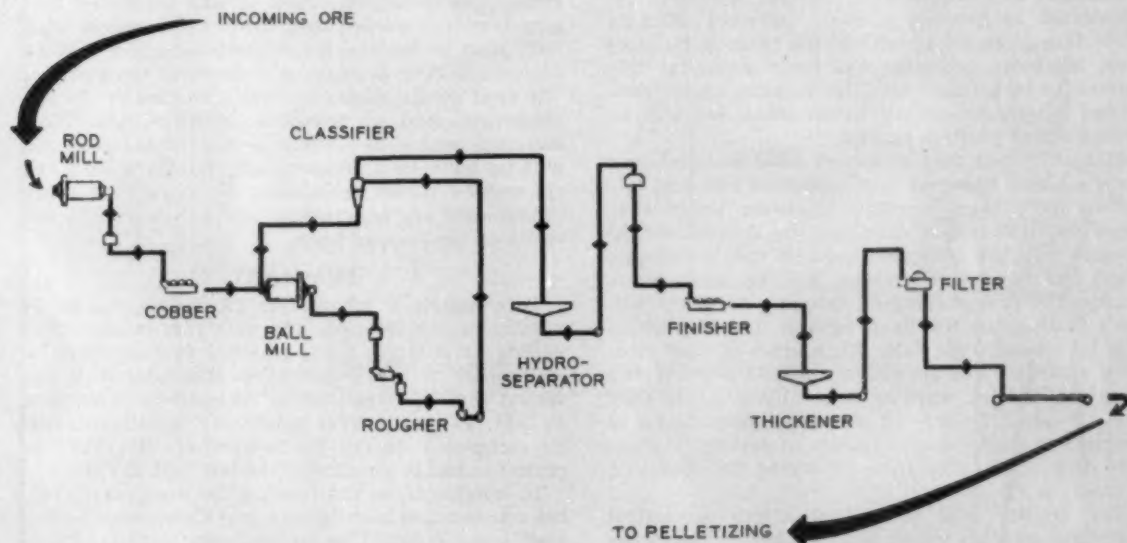


Fig. 3. Flowsheet of concentration plant.

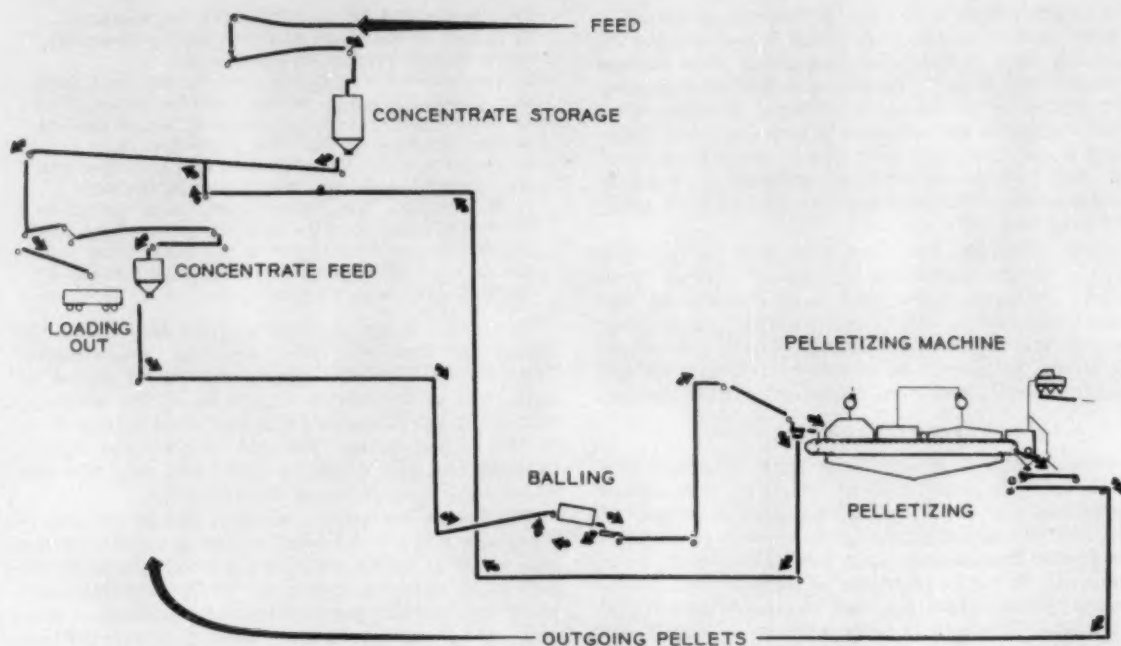


Fig. 4. Flowsheet of pelletizing plant.

gravity through a 20-in. pipeline to the main pump house located near the concentrator. After thickening, fine tailings are also transported by gravity through a pipeline to the south dam of the tailings basin. The line to the north dam will also be a gravity-flow operation in the early years. Return water from the tailings basin is settled after decantation and returned to the concentrator over the tailings trestle. Except during emergency, no water will be discharged from the tailings basin into the Rock Creek flowage.

DUST CONTROL

Much effort has been devoted to the control of dust and fumes throughout the Project. Each building has been considered as a separate problem in ventilation, and adequate air changes have been incorporated to produce a clean and cool working area. Wherever air is withdrawn from a building area, adequate provision has been made for this volume to be brought into the building under controlled conditions. In all blind areas, air will be moved under positive control.

Many types of dust collectors have been selected for the plant; however, wet collectors and bag collectors have been specified wherever possible to avoid the discharge of dust into the atmosphere. In no case will the collectors exhaust into a building area. The individual systems will be balanced to achieve the proper carrying velocity. All ducts will have blast gates for final velocity balance which will be made in the field. All sources of dust have been analyzed, and provision made to prevent any discharge into a working area. Removal of dust alone is not sufficient—in all cases, adequate air is supplied to each exhaust system to prevent a pressure drop in the area from hindering the operation of the fans.

The facility will be equipped with a central maintenance shop which will be operated on a 24-hour, 7-day schedule. In this shop, all the equipment necessary to maintain the plant will be in-

stalled. Each operating area is equipped with maintenance section from which assigned maintenance crews will work.

PELLET HANDLING AT COLUMBIA-GENEVA

In addition to the design of a mine, crushing plant concentrator and pelletizing plant, it was necessary to consider how the product would be handled through the ore storage yards to the blast furnaces at the Columbia-Geneva blast furnaces at Provo, Utah. Although this plant is adequately supplied with unloading, screening, and blending facilities for the present ore shipments from southern Utah, these were not considered to be entirely suitable or adequate for the pellets from Atlantic City.

Various plans to handle and store these new agglomerates were considered. It was concluded that a system was needed to provide the furnaces with long runs of burden constituents which would be uniform in both physical and chemical composition. The final design allows for wet screening of the agglomerates and an adequate surge pile to allow blending over a two-weeks period. This surge pile will be built by a tripper belt and the pellets reclaimed by rotary reclaimers. Suitable bypass arrangements are designed so that pellets can go directly to the furnace bins.

SUMMARY

To complete a job of this magnitude within 24 months in this location, and with the weather prevailing at Atlantic City, seasonal factors must be recognized in the construction schedule. It is essential that all structures be enclosed by November 1, 1961, so that process machinery installation can be completed during the winter of 1961-1962 to permit initial production in the last half of 1962.

In summary, the engineering has been completed, the construction is underway, and Columbia-Geneva now looks forward to an operating facility which will produce a high-grade agglomerate for the Geneva blast furnaces.

SME BULLETIN BOARD

Reports of Your Technical Society



Meetings Past

First International Symposium on Agglomeration (p. 500)

CIM Annual Meeting (p. 502)

and Future

Froth Flotation Commemoration Meeting (p. 498)

Joint Meeting, Industrial Minerals Division AIME-CIM (p. 507)

Education

- Scholarships and Education News, p. 504
- Coal Division News, p. 505

NOTE: Advertising in this issue is included on the reader service card, see p. 445. Circle, on the card, the "key" number given with the ad to obtain further information.



HARDINGE AWARD PRESENTATION

See page 498

SME Preprint List

pages 516, 519

Information on AIME Transactions (Mining)
Volume 220, 1961—see page 450



THE QUEEN CITY AWAITS YOU— COME TO DENVER THIS FALL



Panoramic view of downtown Denver showing the Denver City and County Building at the extreme left center and the gold-domed State Capitol Building extreme right.

Denver in September invites you to attend the half-century's greatest minerals beneficiation program. Six, non-conflicting, technical sessions on the subject of Flotation will be held. All phases of the subject will be covered, but the new, the novel, the experimental, and the theoretical will be emphasized.

We refer, of course, to the Commemoration of the 50th Anniversary of Froth Flotation in the U.S. to be held in Denver September 17 to 20. Headquarters for the sessions will be the Brown Palace Hotel and the Cosmopolitan.

The registration fee will include a bound copy of all the reprints of the papers to be given. An Anniversary Volume on Flotation is also being prepared by outstanding authorities in the field, most of whom you will be able to meet at Denver. By purchasing your copy in advance you will be helping out MBD. The price to members, prepaid, is \$8.

As a bonus, you will be able to enjoy Colorado at the most perfect time of the year. We hope you will visit our Rockies and some of the nearby attractions, old and new. A Ladies Program is being planned to see to it that your wife enjoys her-

self too. Our mountains and hospitality are equally famous.

For detailed information concerning the Commemoration of the 50th Anniversary of Froth Flotation, please circle No. 100 on the business reply card found on page 445 of this issue of MINING ENGINEERING.

Proposed Amendment to the SME Bylaws

The report of the SME Planning Committee for the purpose of studying the matter of a permanent planning committee proposed an amendment to the Society of Mining Engineers Bylaws. At its meeting in St. Louis, in February, the SME Board directed the Secretary to put into action the machinery necessary to implement the proposal of the Committee as provided in Article XII, Sections 1 and 2 of the SME Bylaws.

As directed, the text of the proposed amendment is printed below for the information of the members.

"Proposal by the Organizing Committee that the Bylaws of the Society of Mining Engineers be so amended as to provide a new Standing Committee under Article VII, Section 2,

to be designated as 'Planning Committee', and to make other changes in that Article, as follows:

Section 9 shall be changed to Section 10."

"A new Section 9 is proposed to be added to Article VII directly following the present Section 8, to read as follows:

Section 9 (new). The Planning Committee shall consist of 12 members in all, two selected by each of the four Divisions and four from the membership at large, for terms of five years each. The members-at-large shall be selected by the Nominating Committee of the Society. The initial Planning Committee shall consist of four members with five-year term, four with four-year term, and four with three-year term, to be designated by lot, and each member on expiration of his term shall be replaced in the established manner by selection by the respective Division (Continued on page 515)

Special Presentation of Hardinge Award Made to R. B. Ladoo

Raymond B. Ladoo, this year's recipient of the Hal Williams Hardinge Award, was unable to attend the Annual Meeting in St. Louis because of illness and so did not receive his award at the Industrial Minerals Division Luncheon as is customary. Early last month J. E. Gillson, AIME Past-President, traveled up to Newton, Mass., to make the presentation at Mr. Ladoo's home, accompanied by Donald R. Tone, Assistant Secretary of SME.

The Citation prepared in honor of Mr. Ladoo reads: "For his work as engineer and author in bringing about wider recognition of the vital part played by industrial minerals in the national economy."



Joseph E. Gillson, Past-President of AIME, presents the Hardinge Award plaque to Raymond B. Ladoo as Donald R. Tone, Assistant Secretary of SME, looks on.



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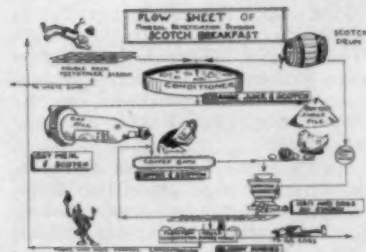
913 Glasgow Avenue

Fort Wayne 3, Indiana

MBD Sends \$2000 to United Engineers' Building Fund

St. Louis Technical Program

Scotch Breakfast



Annual Business Meeting

MBD Luncheon

As you all know, the Annual Meeting is the wind-up of one year's activities but is just as surely the beginning of another. MBD increased in stature and wisdom in 1980. We are confident your officers for 1981 will do as well, though not without the willing help and cooperation of each of you.—W. T. Marston, Secretary-Treasurer.

March 9, 1961

Dr. E. O. Kirkendall, Secretary
American Institute of Mining, Metallurgical and Petroleum Engineers
29 West 39th Street
New York 18, New York

Dear Dr. Kirkendall:

The Minerals Beneficiation Division, AIME, is pleased to forward herewith its check in the amount of \$2000 as a contribution to the UET Engineering Societies Building Fund. The check represents full payment on the pledge card submitted by the undersigned on March 2, 1961.

This contribution was authorized, in accordance with the MBD By-Laws, by the MBD Executive Committee in session on February 27, 1961.

Very truly yours,
/s/ H. R. Spedden

MAY 1961, MINING ENGINEERING—499

1st International Agglomeration Symposium

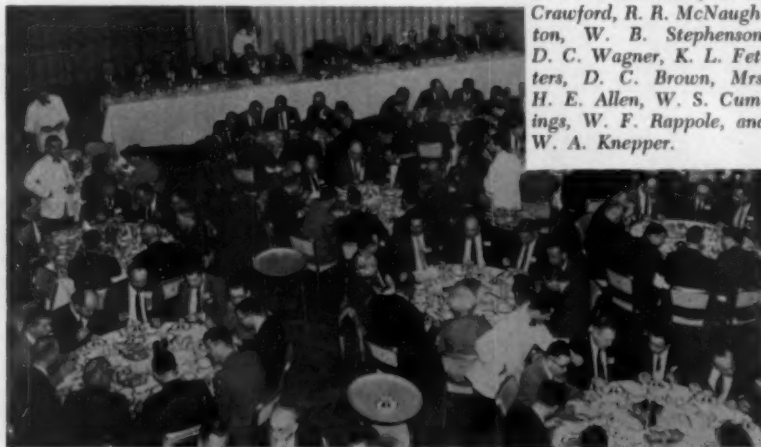


A number of representatives from abroad were seated at the head table for the Fellowship Dinner. They are left to right: H. Sawamoto, Japan; John Stalhed, Sweden; A. M. Decker, Belgium; F. J. McMulkin, Canada; Jacques Astier, France; Gordon Chambers, U.S.; Gaylord P. Harnwell, guest speaker; W. B. Stephenson, President-Elect SME; R. R. McNaughton, AIME President; Frank A. Green, Australia; Helmut Wendeborn, Germany; J. H. White, England; Aksel K. Prestrud, Norway; and P. G. Kihstedt, Sweden.



The audience at the technical session Wednesday afternoon listens attentively as H. B. Chambury reads an extract of a paper by T. D. de Santos, Sao Paulo, Brazil entitled *Tumbling Resistance and Reducibility Tests for Evaluating Nickel Silicate Ore Sinter*.

Below: at the Welcoming Luncheon from left: E. O. Kirkendall, K. H. Roll, F. M. Hamilton, C. F. Clausen, T. B. Counselman, B. E. Crawford, R. R. McNaughton, W. B. Stephenson, D. C. Wagner, K. L. Feters, D. C. Brown, Mrs. H. E. Allen, W. S. Cummings, W. F. Rappole, and W. A. Knepper.



Everyone concerned with the planning of the First International Symposium on Agglomeration, which met in Philadelphia from April 12 to 14, can take pride in the results. Well over 600 men registered, many of them coming from foreign lands. One of the factors contributing to this large attendance by American and foreign engineers was undoubtedly the fact that the meeting was not only well planned in itself but also was carefully integrated as to timing, with the 44th National Open Hearth Steel Conference and 1961 Blast Furnace, Coke Oven and Raw Materials Conference, which immediately preceded it at the Sheraton Hotel on April 10 to 12. This made it possible for visitors to combine three important meetings in one trip.

Among the countries represented at the Symposium were England, Canada, Norway, Sweden, France, Australia, Belgium, Mexico, Germany, Japan, Switzerland, Netherlands, Italy, Brazil, and Venezuela.

Six technical sessions were held during the three-day period, in which 35 papers were presented. French and German translators were present at all technical sessions and other functions for the convenience of non-English speaking registrants.

An excellent feature of the symposium was the set up at the luncheons to enable those interested to discuss the papers with their authors.

The Welcoming Luncheon on Wednesday, April 12 featured a brief address by Donald C. Wagner, Managing Director of the City of Philadelphia on behalf of Mayor Dilworth, and a speech by R. R. McNaughton, President of AIME. Mr. McNaughton's speech concerned itself with the relationship of science and engineering, briefly tracing the development from early in the 18th

century. His opening statement clearly established the difference in the point of view of the scientist and the engineer. He pointed out that the object of science is knowledge while the object of art is works, and he considers engineering the modern version of ancient practical arts. The engineers task is that of devising, planning, and providing the means of effectively and efficiently meeting the material needs of civilized life, and the findings of science are of value to him only insofar as they enable him to better meet his professional obligations.

Gaylord P. Harnwell, President of the University of Pennsylvania, was guest speaker at the Fellowship dinner Thursday evening. His subject was *Education in the World Community*. Dr. Harnwell made the point that education, in its broadest sense, is the center of the effort toward world peace and that the tasks confronting higher education in world affairs require the collaboration of the universities of all nations, for new patterns of education are emerging which call for the sharing of experience and competence.

For a listing of the papers presented at the Symposium see the program in the February issue of *MINING ENGINEERING* beginning on page 194. The bound volume of the Proceedings will be ready for distribution sometime in September. Copies will be sent to registrants as a part of their registration fee. For those who were unable to attend the Symposium and are interested in having the Proceedings, it will be available to AIME members for \$20, and to all others for \$25.

Although the formal program ended on Friday, there remained one more event on the schedule for the indefatigable visitor who still hadn't done enough.

The Bethlehem Steel Corp. offered the facilities of its Grace mine at Morgantown, Pa., for a field trip on Saturday for interested visitors. More than a hundred people signed up for the trip, which provided the final "grace" note to the conference.



An aerial view of the Bethlehem Steel Corp.'s Grace Mine at Morgantown, Pa., site of a post-meeting field trip which was arranged for those interested on Saturday. A tour of its facilities ended the crowded schedule of events of the three-day conference.



The registration area of any convention is a favorite gathering place for those attending and the Agglomeration Symposium was no exception. Several of the registrants found a quiet corner to exchange views during the comparative calm of a lunchtime lull.

Shown at pre-luncheon cocktail party, some of the people responsible for the meeting's success. Below, left, members of the Symposium Advisory Board pose with W. B. Stephenson, General Chairman. Left to right: K. H. Roll, T. B. Counselman, W. B. Stephenson, F. H. Hamilton, and C. F. Clausen. A. Y. Bethune, another member of the Board was absent at the time. In the other picture standing from left to right are: Newell Appleton, vice chairman Arrangements Committee; W. F. Rappold, chairman Arrangements Committee; Mrs. H. E. Allen, chairman Ladies Committee; W. B. Stephenson; Dwight C. Brown, chairman Program Committee; and W. A. Knepper, chairman Publications Committee. William S. Cumings, chairman of Finance Committee wasn't present.



Canadian Mining and Metal Men Gather in Quebec City for Their 63rd Annual Meeting

Canadian Institute of Mining and Metallurgy's Annual Meeting, held in Quebec City March 20 to 22, proved one of the high spots in the long series of successful meetings of the CIM. The technical program, the social events, the attendance, the meeting place, and the weather combined to make it a most rewarding affair.

Attendance was approximately 1600 including close to 500 ladies, attracted no doubt by the charming atmosphere of the Chateau Frontenac, the excellent neighboring restaurants, and the many points of interest in the historic city. Industrial companies in the mining and metallurgical field outdid themselves in providing refreshment, not only in individual rooms, but in daily public receptions before each luncheon and before the annual dinners on Tuesday night and the ball on Wednesday. Before the latter, the Gardner-Denver Co. invited what appeared to be a majority of registrants to a buffet supper. A four-act variety show was presented on Monday night for the entertainment of both the ladies and gentlemen. Following custom, the men and women held separate annual dinners, a practice which lends itself better to the limited capacity of most hotel ballrooms, and permits more interesting programming for each group.

The highlight of the Annual Dinner was the presentation of Institute Honors and Awards. This was of special interest to AIME members



CIM members and guests enjoy themselves during the dinner at the Chateau Frontenac.

attending because among those so honored in the course of the evening was R. R. McNaughton, AIME's newly installed President. Mr. McNaughton received the Selwyn G. Blaylock Medal, which is awarded for distinguished service to Canada through exceptional achievement in the field of mining, metallurgy, or geology.

CIM's affairs for the next year will be in the capable hands of the new President, J. B. Mawdsley, head of the department of geological engineering at the University of Saskatchewan; and C. Gerow, the Secretary, of Montreal, and his assistant, E. G. Tapp. Next year's annual meeting will be held in Ottawa.

A total of 24 technical sessions were scheduled for the three-day meeting during which 96 papers were presented. Metallurgy, including extractive metallurgy and mineral dressing with five sessions, physical metallurgy with two, and iron and steel production with two, dominated the meeting. Five sessions of five papers each were devoted to geology and geophysics; three sessions each to metal mining and industrial minerals; one to coal; and one to petroleum and natural gas. Two sessions were given over to general subjects and joint sessions. Attendance taxed the capacity of some of the small meeting rooms. Discussion often had to be postponed or eliminated to give time for a more complete presentation of the papers.

Papers of particular interest at the mining sessions were one on a friction hoist at the Opemiska mine which was a novelty to many mining men; one on undercut and fill mining at Inco's Frood-Stobie mine, which was illustrated with some extremely good color slides of underground operations; and an excellent summary of mine grouting materials in which

ordinary cement grouts, sodium silicate grouts, chrome lignin, and American Cyanamid's AM-9 were contrasted.

Also to be noted was a paper on the use of the cheap explosive made possible by mixing ammonium nitrate with fuel oil (see *MINING ENGINEERING* April 1961, p. 377); one on new rock-bolting devices, with a few samples available to take home; and the story of the Caland dredging project, where a subsidiary of Inland Steel has successfully removed 161 million cu yd of silt at the bottom of a lake in order to get at an important iron ore deposit at Steep Rock Lake.

H. R. Rice, University of Toronto, presented a talk on what is going on in Soviet Russia, which was of general interest and gave the listeners much food for thought. His report was based on observations made during his visit to Russia in May and June of last year on an exchange lectureship arranged between the Academy of Sciences of the USSR and the National Research Council of Canada. Large expenditures are made for research in various mining fields which were detailed by the speaker. He was impressed by the tremendous significance attached to the mineral industries in terms of prestige accorded to workers in the field, and the rate of investment in capital works. There are 40,000 geologists of Bachelor level or higher engaged in mineral exploration.

The industrial minerals sessions featured a panel discussion on *What's New in Materials Handling*. The two papers presented at the coal session had to do with economics. Mineral dressing received less attention this year than at some previous meetings, but there were papers describing the Levack mill and sand plant, the

(Continued on page 507)



Three distinguished Canadians get together at the annual banquet. They are from left to right: R. R. McNaughton, AIME President 1961-62; W. H. Durrell, CIM President for 1960-61; and J. B. Mawdsley, this year's president of CIM.



ROCK IN THE BOX

Mining & Exploration Division

This is the month to officially welcome to Rock in the Box a new unit of the Mining and Exploration Division of the Society of Mining Engineers. It will be known as the Geological Engineering Unit. The Unit Committee Chairman is Shirley A. Lynch, head of the department of geology and geophysics at Texas A & M. His vital statistics and his cohorts in the job of forming this new unit are listed elsewhere in the column. We might say here that Professor Lynch is a man of many varied accomplishments and lots of drive. His enthusiasm and optimism for the new unit is wonderful.

Rather than try to phrase in our own words what Professor Lynch has in mind for the Geological Engineering Unit, we will quote from his letter to your editor.

"As to the new group of geological engineers, we hope to get it moving soon and rapidly develop it into a division rather than a unit committee. There are many facets to the general field of geological engineering, but we are approaching them as engineers with training in earth science rather than as engineering geologists. Note that the noun is engineers and not geologists. Therefore, we feel there is no conflict with our friends, the engineering geologists, who rightfully belong to the California Association of Engineering Geologists or to the Division of Engineering Geology of the Geological Society of America. Present members of AIME who do not have membership in the Society of Mining Engineers and who wish to become active as geological engineers should pay the additional \$4.00 and affiliate with the Society of Mining Engineers, Division of Mining and Exploration.

We plan to have papers on geological engineering at the next annual meeting and those people interested in presenting a paper should contact **Dean James N. Neilson**, Michigan College of Mining and Technology, Houghton, Mich., Publication Chairman."

You can see, that, in Professor Lynch's words, the emphasis will be on engineering. Perhaps no better idea of what the geological engineer does can be gained than by noting

what the Chairman of the Unit has been doing for the last few years. In addition to heading up the geology and geophysics department at Texas A & M, he has found time to publish numerous papers on currents and sedimentation, petroleum property valuation, water flooding reports for various oil fields, beach erosion problems, and economics and engineering studies of the mineral potential of several Central American countries.

Biography of Chairman

Shirley A. Lynch was born in Girard, Ill., March 31, 1901 and graduated from Girard Township High School in 1920. He took pre-engineering at James Millikin University, Decatur, Ill. from 1920 to 1922. He attended the University of Wisconsin in the summer of 1922 and the University of Missouri School of Mines, Rolla from 1925 to 1929, receiving a B.S. in mining engineering in 1929, an M.S. in 1931, and the professional degree of Engineer of Mines in 1935. He also attended the University of Texas in 1939-1940 for two summers and took special courses while a visiting professor at North Texas State College.

He initially elected electrical engineering, and after completing the pre-engineering courses secured employment with the Illinois Terminal System, an electrical railroad covering central Illinois, and later in the testing department of Westinghouse Electric Co., East Pittsburgh. Following the death of his father, he returned to Illinois to care for his mother; he taught mathematics in high school for two years before entering the Missouri School of Mines.

In 1929 he became associate professor of mathematics at Arlington State College, a unit of the Texas A & M College System. He organized a department of geology in 1934 which grew to a three-man department. In 1946 he came to Texas A & M College to reorganize the department of geology. It was moved to the School of Engineering, curricula in geological engineering, geophysics, and five-year, two-degree combinations with petroleum engineering and civil engineering were developed, with B.S., M.S., and Ph.D. degrees in all areas

Since 1929 Lynch has been engaged in consulting in mining, petroleum, and geological engineering and he is a registered professional engineer in all three of these fields. His work has included evaluations of petroleum properties, prospecting and estimation of ore reserves by extensive core drilling programs, numerous hydrological studies in the coastal swamps and estuaries, salt water disposal problems, coast and bay shore erosion problems, water-flood prospects for secondary recovery of petroleum; he also served as an expert witness in many legal problems. He has made eight trips to various Central American countries to prospect for, and evaluate mineral deposits.

Unit Committee Appointments

Most of the Unit Committee posts have now been filled, and we take pleasure in introducing the men who will be serving in them for the balance of the 1961-62 term.

The Underground Mining Unit under the chairmanship of Richard M. Stewart includes: James W. Clemens, general operating engineer, M. A. Hana Co.—membership; Joseph B. Elizondo, mine manager, White Pine Copper Co.—program; and Jeremy Farmin—publications.

Members of the Open Pit Mining Unit serving under Henry J. Schwelzenbach are: Martin Hannifan, manager, mines, Anaconda Copper Co., Butte—program; and Elmer R. Drevdahl, associate professor of mining engineering, University of Arizona—publications.

The Geochemical Unit, headed by Douglas R. Cook consists of Harold Bloom, professor of geology, Colorado School of Mines—membership; R. J. P. Lyons, senior geologist, Stanford Research Inc.—program; and John K. Hayes, supervisor raw materials exploration, Columbia Iron Mining Co.—publications.

The Geophysical Unit which William C. Kellogg heads includes David Coolbaugh—program; and Ross Whipple, Columbia Iron Mining Co.—publications.

The Geology Unit, under H. E. Harper is made up of Ernest E. Thurlow, chief mining geologist, Northern Pacific RR Co.—membership; Rolland B. Mulchay, assistant

(Continued on page 506)

Education News

University of Arizona to Offer Materials Engineering Degree

Beginning in September, the department of mining and metallurgical engineering will offer a M.S. degree in materials engineering. Students should have a bachelor's degree in engineering to qualify for entering graduate work in this field. Materials engineering deals with the compatibility of the different kinds of materials which are used in the development of devices that utilize nuclear energy.

Summer Institute to be Held at Colorado School of Mines

A six-weeks institute for high school science teachers will be held at the Colorado School of Mines this summer. The institute, one of the few ever proposed for the earth science area of study, will combine chemistry and geology principles in a teaching program designed to supplement science backgrounds for junior and senior high school science teachers. The National Science Foundation will support the institute through a \$46,100 grant to the mineral engineering college. The primary goal of the program is to provide concentrated chemistry and geology course material for those teachers whose background in science is weak. The aim of such institute programming is to increase the quality of science teaching on the secondary level.

Fifty teachers from all sections of the country will be accepted for the 1961 institute. Stipends amounting to \$75 will be given to each teacher each week for the duration of the institute. Married teachers may draw as much as \$60 per week for dependents. The institute will also

pay some or all of the transportation expenses, up to \$80.

New Building Planned for University of Alabama

The University of Alabama has begun work on a new mineral industries building to house the departments of chemical, metallurgical, and mining engineering. The three-story structure will also provide for radioactive isotopes laboratories. The building will house the engineering library, providing more than triple the space now available; the Bureau of Engineering Research; and the placement bureau and administration offices of Alabama's college of engineering.

Research Program at Michigan College of Mining and Technology

Two research specialists have come from opposite sides of the globe to carry out basic research on mineral problems. They are the first participants in a new program at Michigan College of Mining and Technology in which highly qualified researchers from other countries are invited to come here and work a year. The two men are Hiroshi Kuno, an assistant professor on the faculty of Kelo University, Tokyo and Adnan Göksel, an associate professor at Istanbul University. Mr. Kuno has undertaken a study of froths in flotation environments and Mr. Göksel is carrying on an investigation of agglomeration characteristics of Michigan's iron ore.

Scholarships

New York University Receives American Metal Climax Grant

The American Metal Climax Foundation Inc. has made a grant

of \$50,000 to New York University for the establishment of a fellowship in its graduate school of business administration to be known as the American Metal Climax Foundation Inc. Fellowship, in honor of Hans A. Vogelstein, a former president of American Metal Climax Inc. Mr. Vogelstein died recently after a prolonged illness. The selection of students to receive fellowships will be left entirely to the discretion of the University.

National Science Foundation Grant

Donald H. Yardley of the mineral engineering staff of the University of Minnesota has been given a National Science Foundation grant for the sum of \$25,500 to make a study of Trace Element Distribution in Swamp Environment. The objective of this work is to determine the nature of the geochemical distribution patterns of certain trace elements in a swamp environment overlying a mineralized contact. Another aspect is to investigate the factors which affect or control geochemical mobility and distribution in such an environment, and the relationship to neighboring environments overlying a similar geologic setting.

Jane Heller Lewis Fellowships

The mining department of the University of California at Berkeley has received a bequest from the estate of the late Martin J. Heller to establish fellowships for graduate research in mining and mining engineering. The bequest totals about \$1½ million, and present receipts are sufficient to grant a few fellowships for the academic year 1961-62.

These fellowships, ranging from \$3500 a year on the Masters level to \$4500 a year on the Doctoral level, are to be competitive for students in schools throughout the U. S. and the free world, as well as for recent graduates from such schools.

Chester H. Steele Honor Awards

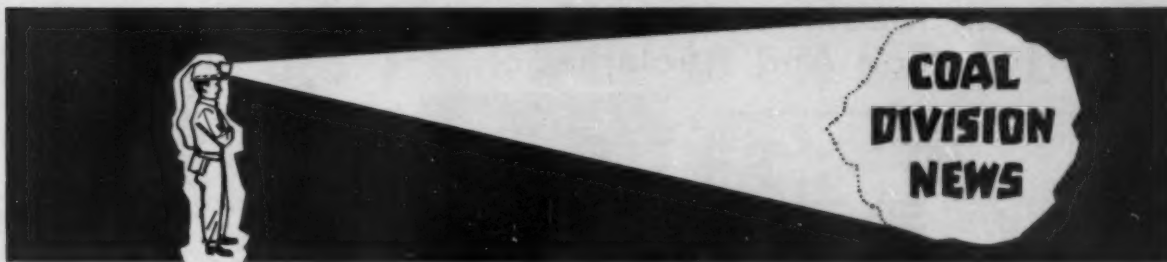
Two Chester H. Steele Honor Awards in the amount of \$250 each have been established at Montana School of Mines by Aime C. Steele in honor of her late husband. Mr. Steele was vice president in charge of Western Operations for the Anaconda Co. and is an alumnus of Montana School of Mines.

The awards will be in recognition of exceptional scholastic achievement. One will be given to an outstanding student of the graduating class, and the other to an outstanding member of the graduating class who did work in mining geology. Both of the awards, based upon the scholastic standing of the students at the time of graduation, will be made at commencement.

(Continued on page 506)



Seven mining engineering students from the University of Washington, Seattle, pictured during a tour of the Bunker Hill Co.'s mine, concentrator, and lead smelter at Kellogg, Idaho. Left to right: Leo Lindbloom, John Prochnau, Jeffrey White, John Rudin, Clarke Stockwell, Bill Todd, Mike McCleary, and Professor Drury A. Pifer.



Report of Scholarship Selection Committee

During the year 1960-61 the Coal Division had only four requests for scholarships. They are as follows:

Gary Reeder, a senior at Pennsylvania State University applied for and was awarded a scholarship for \$225 for the second semester. Mr. Reeder's academic adviser and also Professor Howard Hartman recommended him most highly. They stated that he did excellent work as a part-time employee of the Department of Mining at the university. While still a junior at the university, he was elected president of the local student chapter of AIME.

Paul Edward Barnett, as a freshman at West Virginia University, was awarded a \$350 Coal Division-AIME Scholarship. He ranked third in a class of 60 in high school.

William E. Lindquist was awarded a \$400 Coal Division-AIME Scholarship for his sophomore year at Pennsylvania State University. The award was made on the basis of his work for the previous year at the university. He was recommended for the scholarship by Professor H. B. Charnbury.

Douglas MacArthur Sutherland attended Virginia Polytechnic Institute and had completed two-quarters work in mining engineering. He was recommended by Professor C. T. Holland for a Coal Division-AIME Scholarship. As a sophomore he was awarded a scholarship of \$400, but later found that even with the aid of the scholarship he would be unable to continue his college career, and so declined the award.

The scholarship awards are for the following amounts: Freshman \$350 per year, sophomore \$400 per year, and junior and senior \$450 per year.

However, the recipients of the scholarships receive a check for only half the amount for the first semester of the college year. The balance is sent after a transcript of his grades for the first semester proves to the Committee that he is doing satisfactory work.

The members of the Scholarship Selection Committee for the past year were: Edward A. Dines, University of Pittsburgh; R. T. Gallagher, Lehigh University; Charles T. Holland, Virginia Polytechnic Institute; G. Ralph Spindler, West

Virginia University; and Ernest M. Spokes, University of Kentucky. Charles E. Lawall served as chairman and M. D. Cooper served as co-chairman.

Hugo Nyquist is chairman of the Scholarship Fund Committee. He and his committee have been very effective in providing funds for scholarships so that the Scholarship Committee has had funds to award scholarships to all candidates who have applied and have met the requirements of the Committee. As of December 31, 1960 there was a balance of \$4,595.75 in the Fund.—Charles E. Lawall.

Other Scholarship Programs Sponsored by the Coal Industry

Illinois Mining Institute

Each year the Illinois Mining Institute gives four \$500 scholarships to the University of Illinois, Department of Mining and Metallurgical Engineering and one \$500 scholarship to the University of Missouri School of Mines and Metallurgy.

University of Illinois

In a report to the Illinois Mining Institute, A. G. Ricketts representing the University told them that three students hold Old Ben Coal Corp. scholarships and one student holds a Sahara Coal Co. scholarship.

University of Missouri School of Mines

George B. Clark reported that Truax-Traer Coal Co. set up a scholarship for one of the students attending the Missouri School of Mines.

Frank Ellis Christopher Coal Mining Scholarship

The first annual Frank Ellis Christopher Coal Mining Scholarship to the University of West Virginia will be awarded in 1961 to a West Virginia student engineer or son of a coal mining family. Mrs. Virginia Christopher Farland established the grant in memory of her father, who founded the Christopher Coal Co. 25 years ago.

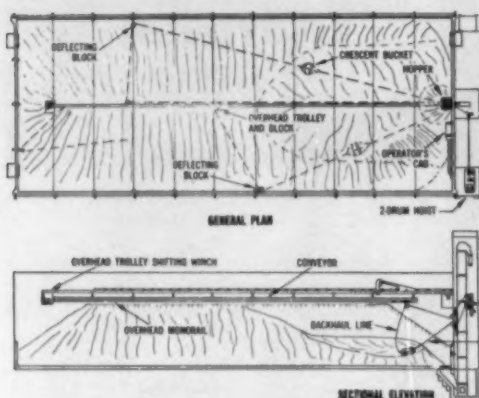
\$1000 Gift Added to Loan Fund of West Virginia University

A \$1000 gift from the Central West Virginia Coal Mining Institute has increased to \$7000, the amount in a West Virginia University loan fund for mining engineering students from the central part of the state. The fund was established in 1952 by an initial contribution of \$4000 and was later increased to \$6000. The fund provides annual loans of \$500 for four years to qualified students, the loans to be repaid over a similar period following graduation. Sons of families residing in Harrison, Taylor, Barbour, Upshur, Randolph, and Tucker counties are eligible.

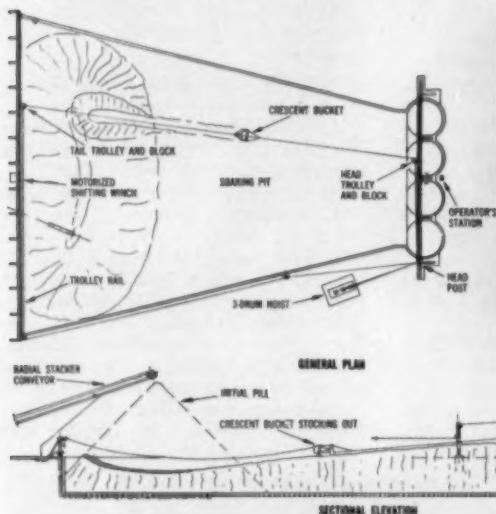


William E. Lindquist, right, receives his AIME Coal Division scholarship check from H. B. Charnbury, head of the Department of Mineral Preparation, Pennsylvania State University. There are several other scholarships available at the college to students majoring in mineral preparation engineering in addition to the one given by AIME.

Sauerman Machines And Methods For Storage And Reclamation



Drawing and photograph illustrate DragScraper Machine using an elevated monorail trolley system along the center line of the storage building for straight-line recovery of bulk material. Overhead trolley and block are controlled by a shifting winch. Recovery is to a hopper located at center of one end wall. Deflecting blocks placed on the side walls permit the bucket to reclaim material from side areas.



Installation drawing shows details of DragScraper Machine handling shale in a soaking pit. Monorail trolleys at each end provide lateral shifting for the Crescent. The third drum on the hoist is used to shift the head end trolley and a motorized winch shifts the tail trolley assembly. The Sauerman stocks out from initial piles, reclaims shale to the wash mills at head end as required. Photo shows Crescent bucket on pile. Shifting winch, trolley rail and conveyor system are in background.

Sauerman Machines stockpile and reclaim bulk materials from buildings, bins and ground storage piles. The Crescent scraper bucket can deliver directly to one or more hoppers at ground level, to conveyors and processing machines or up a ramp to an elevated hopper.

Users of DragScraper Storage Systems find this equipment handles material at less cost per ton than other methods of stockpiling or reclaiming. DragScrapers are economical to operate in limited indoor storage facilities or ground storage areas of several acres or more. Materials handled vary in weight up to 200 lb. per cu. ft. Sauerman Machines are built in sizes from $\frac{1}{4}$ to 15 yd. to match your tonnage requirements.

Call or write for recommendations on your material handling job. Catalog E gives specifications and general information.

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Crescent Scrapers • Stockline and Tautline Cables • Duroline Blocks

Scholarships

(Continued from page 504)

Peacock Memorial Prize

The Walker Mineralogical Club recently announced that its Peacock Memorial Prize for 1960 was awarded to Joseph E. Patchett for his paper entitled *A Study of the Radioactive Minerals of the Uraniferous Conglomerate, Blind River Area*. A native of Middletown, N. Y., Dr. Patchett's work for the paper was done at the University of Toronto.

The Peacock Memorial Prize of \$200 is offered annually by the Walker Mineralogical Club for the best scientific paper on pure or applied mineralogy, including crystallography, mineralogy petrology, ore genesis, and geochemistry submitted by a graduate student enrolled in a Canadian university, a Canadian graduate student enrolled in any university, or any graduate student on a Canadian subject. Closing date for this year's competition is Dec. 31, 1961. Submit papers to: The Secretary, Walker Mineralogical Club, 100 Queen's Park, Toronto, 5 Ont., accompanied by a letter from project supervisor stating the nature and extent of the help he may have given to the work submitted. Papers may be in the form of a thesis, a paper ready for publication, or a printed publication.

Rock in the Box

(Continued from page 503)

chief geologist, The Anaconda Co.—program; and Earl F. Cook, Dean, College of Mines, University of Idaho—publications.

The new **Geological Engineering Unit** working with Shirley A. Lynch is comprised of: William R. Higgs, Louisiana Tech. Station—membership; James N. Neilson, professor of geological engineering, Michigan College of Mining and Technology—program; and Parker D. Trask, professor of geological engineering, University of California—publications.

Two other important appointments in the Divisional set-up are those of J. G. Hall as Chairman of the Executive Committee and R. J. Lacy as Chairman of the Nominating Committee.

DON'T FORGET THE BUILDING FUND!

**M&E DIVISION
NEWS EDITOR
Peter B. Nalle**

Riverside Cement Co.
Box 832
Riverside, California

INDUSTRIAL MINERALS NEWSLETTER



Canadian Joint Meeting

Canada here we come! October 2 and 3 the Division will join with the Industrial Minerals Division of The Canadian Institute of Mining and Metallurgy in an Industrial Minerals Conference at Ottawa, Ont. John Broughton is the committeeman representing the Division. Honorary Chairman of the session will be Monty Goudge; Active Chairman will be H. M. Woodroffe. Better set aside the date now. It will be a memorable event.

Program plans to date include a panel discussion to be held Monday morning, October 2 and technical sessions on Monday afternoon and Tuesday morning. Luncheons have been planned for Monday and Tuesday and a dinner will be held Monday night.

Five field trips (informal) have been scheduled: 1) asbestos operations at Thetford Mines and Asbestos, Quebec; 2) talc mining and processing, Highwater, Quebec; 3) magnesitic dolomite to basic refractories operation, Kilmar, Quebec; 4) brucite mining and processing, Wakefield, Quebec; and 5) nepheline syenite quarries and beneficiation plants at Blue Mountain, near Peterborough, Ontario. It will be worth your while to plan to visit one or more of these sites on your way home from the meeting.

All activities connected with the session will be at the Chateau Laurier Hotel in downtown Ottawa, a stone's throw from the Parliament Buildings. There will probably be enough room in the Chateau to accommodate everyone. Overnight parking (6 pm to 8 am) is free. For those who prefer motels and are willing to do some commuting, this can be arranged.

Watch for more details in subsequent issues of your Division Newsletter.

Executive Committee Considerations

Business and policy affairs of the Industrial Minerals Division were considered by the Executive Committee in its meeting at St. Louis. A number of members of the Division also attended and took part in the deliberations.

Newly elected officers were installed and appointments for the year confirmed. The list of officers and appointees was published in MINING ENGINEERING last month.

Ray Kazmann, the hard-working chairman of the new Program Policy Committee, described preliminary program plans. A reduction in number of sessions is planned. There will be an attempt to hold more joint sessions with other divisions since industrial minerals' interests cross the line on beneficiation, mining, and economics.

To mesh with the newly scheduled annual fall meetings of SME, it is planned to stress the broader type paper at the annual February meeting of AIME. The more specific type of paper will be stressed for the annual fall meetings of SME.

Arrangements for the joint meetings at Las Vegas, Nev., April 24 and 25, and Ottawa, Ontario, October 2 and 3, were made. The latter meeting is ahead of us and promises to be an exceptionally interesting and instructive experience as you can see from your reading of the report at the beginning of the page.

The Executive Committee and other attending members were concerned with an apparent loss in membership by the Division. It was determined that the loss is more apparent than real. The difficulty seems to lie in the method of showing first interest preference on AIME application forms, directory forms, etc. Many who are active participants in the Division's work and programs are not listed as members of the Division since they showed, on forms returned by them, a primary interest in mining and exploration. Making such a designation is natural for a mining engineer whether he mines industrial minerals or metallics. Messrs. Sanford Cole, T. L. Kessler, Don Emigh, and Warren Wagner were appointed to investigate the situation and make appropriate recommendations.

Preparation for an Industrial Minerals Directory was deferred until the method of determining Division membership is reconciled, in order to be certain that all interested in industrial minerals are recognized and listed.

With the many alterations to the Division's bylaws that were adopted during the past year, a need for

clean copy was expressed. The committee that accomplished the excellent job of correcting and bringing the bylaws up to date will prepare the clean copy. They will also prepare such amendments as may be necessary to clarify in the bylaws the present situation on the Program Policy Committee. The bylaws committee consists of Messrs. Frank Hunter, Don Emigh, and John Pattison.—Leon W. Dupuy.

CIM Meeting

(Continued from page 502)

Quebec government pilot plant, copper activation of pyrite, and the use of sulfur dioxide in flotation.

Geology and geophysics papers have always been numerous at CIM meetings, and this year was no exception. One session was devoted to the future role of geologists in various fields. Several papers discussed geological conditions at widely scattered properties including Opemiska, along the Gulf of St. Lawrence; the Coronation mine; the Guayana Shield in Venezuela; and the McIntyre mine. A few papers on geological theory, aerial prospecting, electromagnetic spontaneous polarization, and seismic studies completed the program.

In the field of metallurgy, most attention was given to the subject of extractive metallurgy, with a special forum on roasting. This covered zinc roasting practice at Flin Flon, suspension roasting at Trail, fluid bed practice at Red Lake, practices at Copper Cliff, magnetic roasting, and two papers on roasting in the iron and steel industry.

Other papers covered the practice in aluminum smelting, the leach-precipitation-flotation practice at the Rosita mine in Nicaragua, the Keys autoxidation plant used to produce acid for leach, the research work being done to improve the quality of iron ore shipped from the Labrador-New Quebec area, and the development in Canada of structural steels of higher strength and improved resistance to brittle fracture. There was also a session on physical metallurgy at which four papers were presented.

• The January 20 meeting of the **Oregon Section** featured one of its own members as speaker of the evening. Hollis M. Dole, director of the State of Oregon Department of Geology and Mineral Industries, reviewed the work of his department for 1960 and discussed the projects and areas covered by the various field parties. The extensive geological mapping done by the department over the past years has proved to be extremely valuable to many companies and individuals seeking minerals for their work.

The date of the February meeting was changed from the customary third Friday to the following Wednesday in order to have a joint meeting with the other engineering organizations in the Portland area to commemorate *Engineers' Week*. The meeting was held in the auditorium of the Benson Polytechnic School. Glen DeKraker, manager of electronics and marketing, Sangamo Electric Co., Springfield, Ill., covered the various fields of engineering in his talk, *Engineering—A Career of Opportunity* and tied the opportunities of each field to the space age. In conjunction with the meeting, a panel consisting of members from each engineering society was on hand to offer counseling service to students. Two members of the Oregon Section, Ruby Clark of ALCOA and Jens Thorbjornsen of Reynolds Metals Co., served on the panel.

• The **Southeast Section** held its first meeting of the year February 16 at the Thomas Jefferson Hotel in Birmingham. Eugene K. Graham, Fair-

field Steel Works of the Tennessee Coal and Iron Div., U.S. Steel Corp., traced the parallel growth of TCI and the South since Alabama's first commercial steel was made in 1899. During the course of his talk, he stated that since the turn of the century the South has evolved from an undeveloped agricultural region to one of industrial prominence.

This meeting was also the occasion for the installation of officers for the year 1961. They are: J. W. Nicol, chairman; L. S. Chabot, Jr., 1st vice chairman; C. K. Donohoo, 2nd vice chairman; and M. M. Marchich, secretary-treasurer.

• The **Mexico Section** met February 13 at the University Club in Mexico City where approximately 35 people (members and guests) saw a movie about the study of formations, constitution of soils, and geology. Bion H. Kent, geologist with USGS, commented on the movie and answered questions from the audience about it.

The Section has initiated a policy of inviting students to attend the meetings to give them the opportunity of meeting all of the members. The members also approved the proposal made by Salvador Trevino in the name of the Education Committee that the economic aid to students be increased from 150 pesos to 300 pesos in view of the rise in the cost of living.

At the Section's meeting March 13, Francisco Hawley, an engineer for Anaconda Pirelli Conductores Electricos, S.A., gave an interesting talk on the selection of electric con-

ductors for the mining industry.

• Members of the **El Paso Section** gathered in the Crystal Ballroom of the Hotel Cortez, March 8 to see a film entitled *Highlights in Steel Making*. Joseph C. Rintelen, Jr., chairman of the department of mining and metallurgy at Texas Western College, showed the film and discussed present practices in steel making.



• The **Uranium Section** met February 7 at the M-4 Ranch House in Moab, Utah, where members heard Jay Mayhew of Mayhew Engineers speak on underground storage.

• Thirty-four members and guests of the **Morenci Subsection** (Arizona Section) met at the Longfellow Inn, February 28 for a cocktail hour and dinner meeting. The speaker of the evening was Harry Hemmer, sales engineer with Minneapolis-Honeywell Regulator Co., whose subject was *Automation in the Mineral Industries*.

• The **University of Washington Student Chapter** was the guest of the **North Pacific Section** at its monthly



New officers installed at the Southeast Section February 16 meeting pictured with outgoing Section chairman E. P. Reed are from left: George Bynon, welcome committee; M. M. Marchich, secretary-treasurer; Charles Donohoo, 2nd vice chairman; L. S. Chabot, 1st vice chairman; E. P. Reed; J. W. Nicol, section chairman; P. J. Zukow and W. R. Kirkwood, program chairmen.



At the February 16 meeting of the Southeast Section some of the Section officers posed with the speaker of the evening. From left to right: E. P. Reed, 1960 Section chairman; J. W. Nicol, the newly installed Section chairman; W. K. Graham, assistant general superintendent of Fairfield Steel Works of TCI, guest speaker; and W. R. Kirkwood, program chairman.

meeting January 19, held in Rose's Highway Inn. The Student Chapter was responsible for the program at which Donald Stevens acted as master of ceremonies. The program included: *High Temperature Metallography* by Maurice Kasen, graduate—metallurgical engineering; *A Field Study of a Washington Iron Deposit* by Clarke Stockwell, senior—mining engineering; *Color Metallography* by Roger Coleman, senior—metallurgical engineering; and colored slides of exploration work in Alaska by Willis Beach, junior—mining engineer.

During the meeting Clarke Stockwell, chairman of the Student Chapter, was awarded the Wallace Lippincott Atkinson Annual Award. This Award is given to the outstanding mining student each year. The presentation was made by Drury A. Pifer, director of the School of Mineral Engineering.



G. A. SCHULTZ



W. F. FULGHUM

• On March 7, the **Chicago Section** held another of its split session meetings which are proving to be such a success. Approximately 80 members gathered at the Chicago Bar Association for a joint dinner hour which was followed by separate sessions for SME and MS members. Nearly two-thirds of those present attended the SME session which was devoted to the subject *Materials Bulk Handling*. Two speakers were on hand to cover several aspects of the problem. G. A. Schultz, Finco Inc., discussed engineering and purchasing of a bulk material handling system and W. F. Fulghum, International Mineral and Chemicals Corp., described field applications of flexible materials handling systems. Using numerous color slides by way of illustration, Mr. Fulghum gave examples of hydraulic transportation methods used in Florida phosphate stripping operations and shiftable conveyors and rail haulage methods used in West German lignite open-pit mines.

Members of the Metallurgical Society heard Merrill A. Scheil of A. O. Smith Corp., present a talk entitled *Metal Failures Can Be Explained* in which he discussed the various types of metal failure such as fatigue, stress corrosion, and failure due to hydrogen.

• Members of the **Ajo Subsection** (Arizona Section) held their regular monthly meeting February 9 at the Copper Coffee Shop. The chief

item of business was to approve the revision of Article III of the Subsection's constitution. The evening's program featured an illustrated talk on the manufacturing of explosives at the Benson plant of Apache Powder Co., given by Louis Towle, general superintendent for the company.



• The **San Francisco Section** held its annual dinner dance in conjunction with the Ladies Auxiliary on March 18 in the Gold Ballroom of the Sheraton-Palace Hotel. The evening began with cocktails at 6:30 p.m. Dick Foy and his orchestra provided music for dancing.

• The **Mining Society** (Pennsylvania State University Student Chapter) elected new officers for the second semester of the school year at its meeting December 16, 1960. They are: Donald Roberts, president; Stanley Subolesit, vice president; Joseph Conway, secretary; and Daniel Prusaitis, treasurer.

Following the election, Richard Byers, investment consultant with Green, Ellis, and Anderson, spoke to the group on the characteristics and behavior of the stock market using many corporations in the mineral industries as examples.

The Society's January meeting was purely social and the members turned out in force for the fall semester cabin party. Despite the knee-deep snow, a rousing football game was played. Pinochle and food provided time for drying out around a pot-bellied stove before heading back to the campus.

A spring meeting get-together on February 22 featured movies of the Penn State-USSR gym meet. The meeting held in the mineral sciences auditorium included a business meeting and refreshments.

• More than 50 people, attending the February 15 meeting of the **Tri-State Section** held at the Blue Castle Cafe, Baxter Springs, Kan., heard William C. Hayes' talk *Recent Mineral Exploration in Missouri*. Mr. Hayes, who is assistant state geologist of Missouri, gave special attention to the deeper iron and lead ores and predicted that the new lead discoveries in the south central region of the state would off-set the declining production in the lead belt and Joplin District, and would maintain the state's record as a lead pro-

ducer. The iron ore discoveries are also of great importance to the economy of the area. His talk was illustrated with large wall maps of the state showing the areas of activity.

• The **Midwestern Coal Subsection** (Chicago and St. Louis Sections) met at the Benton Country Club on March 16, beginning with cocktails at 5:30 pm. Speaker on this occasion was R. E. Zimmerman of Paul Weir Co., Chicago, whose subject was *The Hydraulic Transportation of Solids Through Pipelines*. Mr. Zimmerman has done considerable research on the pumping of solids by pipelines for Paul Weir Co. and his talk was both interesting and educational.

• The February meeting of the **Montana Section** was held jointly with the AIME on February 16 at the Montana School of Mines in Butte.



During an important business meeting, the members were brought up to date on the State Highway Commission's attempt to unionize its employees (including professional people), and a course of action was decided upon. Following the business meeting, an informative talk was presented by Donald McGlashan of the Montana School of Mines entitled *Electrokinetics—Its Application to Mineral Processing*. The talk dealt chiefly with the surface reactions of minerals of the solid-liquid interface and stressed the importance of the electrical charge sign and electrokinetic potential of minerals that have a direct bearing on processing whether the application concerns highway aggregates, mineral concentration, or the purification of fluids.

• The **Norwood Mining and Metallurgical Society** (Student Chapter University of Kentucky) has carried on an active program since the beginning of the school year. At its first meeting, September 29, 1960 the following officers were elected: Franklin Mink, president; Leland Allen Pollitt and E. Miller Cope, social co-chairmen; Sam Kegley, treasurer; Alanna L. Mangelsen, secretary; and Jon Jenkins, Sergeant-at-arms. Some of the subjects covered during the fall meetings were job interviewing and what a company representative looks for in a student; registering and licensing for engineers; a movie on the Naval Ordinance Laboratory concerning bombs; and a talk on nonmetallics.

Around the Sections

Continued

There was also a field trip to the Corning Glass plants in Danville and Harrodsburg, Kentucky.

At its two January meetings members heard Ralph Gelder (one of the Society's industry sponsors) talk about his job as chief metallurgist at Armco Works and B. M. Grimm (a representative for Minor E. Pace, the other industry sponsor) tell about his job as preparation plant superintendent for Inland Steel coal plant in Wheelwright, Ky.

- The April 14 meeting of the **St. Louis Section** was held at the Pope Pius XII Library, St. Louis University. Tours of the library were conducted from 5:00 to 6:30 pm at which time dinner was served. The menu included a choice of roast beef or trout. Robert Lawrence, Jr., sales manager of the Iron & Steel Div., M. W. Kellogg Co., New York City, presented a 30-minute film and extemporaneous discussion on a new direct-reduction process named HyL used in the steel industry. The name derives from Hojalata y Lamina, S.A., the leading Mexican steel producers which developed it.

- The **Colorado Section** held its monthly dinner meeting at the Petroleum Club in Denver on March 16. Following dinner, a business meeting was held at which the chief item on the agenda was preliminary financing for the meeting commemorating the 50th Anniversary of Froth Flotation in the U.S. to be held in Denver in September. A resolution was passed authorizing the Section to advance \$500 to meet the initial expenses of the meeting. Then Frank McKinley introduced the speaker of the evening, Charles G. Campbell, superintendent of Basic Oxygen Div., Steel Production Dept., CFI, who

gave a highly interesting talk entitled *Planning, Construction, and Contemplated Operation of Basic Oxygen Production Shop*. The presentation was followed by a lively discussion period.



- The **Carlsbad Potash Section** held its monthly dinner meeting at the Riverside Country Club on February 22. More than 80 persons attended the meeting which was a symposium on the Plowshare Program including the Gnome Project near Carlsbad. The panel was headed by Ernest Wynkoop, AEC project officer, who gave a rundown of the latest developments on Project Gnome in which a nuclear device will be exploded 1200 ft down in a salt bed near the Carlsbad potash mines. The shaft is expected to be completed in May. Also on the panel was Mr. Reeves, program manager for Plowshare and test manager for all of the Nevada tests, who stated that the yield of the nuclear device would be reduced from the original 10 kilotons to 5 and that the project will not be ready before the first part of next year. Others on the panel were Joe V. Sanders, contracting officer and director of Plowshare; O. R. Coats, Reynolds Electrical & Engineering Co.; and James Black, shaft manager for Cementation Co. A short film entitled *Industrial Application of Nuclear Explosives* was shown, followed by a question and answer period.

- A turnout of 168 people, including 27 students from the University of Arizona, for the March 8 meeting of the **Tucson Subsection** (Arizona Section) drew praise from the chairman, Thomas Mitcham, and the promise that the Subsection will continue to present programs which will warrant such interest. The meeting was held at Cliff Manor Motor Hotel. Subject of the evening's program was the development of the Toquepala copper deposit in Peru, S.A. Arthur C. Hall, American Smelting & Refining Co., acted as moderator and introduced the four speakers who each discussed a different phase of the development. J. H. Courtwright's topic was *Selected Features Related to Exploration and Drilling at Toquepala*; W. E. Loerpabel discussed *Organization and Management During the Period of Planning, Engineering, and Design of Toquepala*; K. E. Richard considered *Geological Features Involved in Ore Estimation*; and J. D. Vincent's discussion was titled *Objectives and Methods Employed in the Pilot Plant at Toquepala*.

- Members of the **Washington, D. C. Section** heard Thor Kiilsgaard, geologist with the Base and Ferrous Metals Branch of USGS, speak about the geology and technical aspects of Toquepala and nearby copper deposits of southern Peru at the March 7 meeting. Mr. Kiilsgaard illustrated his talk with color slides taken while he was with the International Cooperation Administration in southern Peru in 1958 and with a color movie about the development of Toquepala. As usual, the meeting was held at the Broadmoor Apartment Hotel with cocktails and dinner preceding the business of the evening.

- At the March 2, 1961 dinner meeting of the **Maricopa Subsection** (Arizona Section), held in the Arizona Ranch House Inn, the members enjoyed a program presented by the General Electric Computer Department entitled *A Computer Carol—Computers Past, Present and Future*.



Members and guests of the Tucson Subsection mingle amiably in the patio of the Cliff Manor Motor Hotel where they had a chance to enjoy the convivialities of good talk and drink.



From left to right: W. E. Loerpabel, Arthur C. Hall, Kenyon E. Richards, and J. Harold Courtright, some of the members of the panel who spoke at the Tucson Subsection March 8 meeting.

According to a recent announcement from Kennecott Copper Corp., **Frank R. Milliken** was elected president to succeed **Charles R. Cox**, who will continue as a director and member of the executive committee of Kennecott. Mr. Milliken was formerly executive vice president of the corporation, a position he assumed in 1958 along with membership on the board of directors. Previously he served as vice president in charge of the company's mining operations from the time he joined the company in 1952. For the preceding ten years he was with National Lead Co. Early in his career he was associated with Peru Mining Co., General Engineering Co., and Kennecott's Utah Copper Division, Salt Lake City.

Following graduation from the University of Washington in December 1960, **Reed M. Miller** went with Climax Molybdenum Co. as a mine trainee.

Thomas E. Bullock has entered private practice under the firm name of Geotechnical Services Co., Burbank, Calif., offering professional services in earth science fields related to engineering, geology, and geophysics. Before opening his own office, Mr. Bullock was chief geophysicist for Dames & Moore.

After five years with Standard Metals Corp., **Russell L. Wood** has become associated with New Jersey Zinc Co.

Upon completion of his studies at the Royal School of Mines, London, England, **K. B. Payne** went to Malaya as assistant to the mine superintendent of Kamunting Tin Dredging Ltd., which is under the management of Anglo-Oriental (Malaya) Ltd.

Ernest R. Rodriguez has been named chief, Spokane Office of Mining Research, USBM, according to a recent announcement. He was transferred from Denver, where he was a mining health and safety engineer in the Bureau's accident prevention health division. He has been with the Bureau since 1949.

The consolidation of the Port Henry (New York) and Chateaugay (New York) districts, iron ore mines operations of Republic Steel Corp., into a single district to be known as the Adirondack District was announced recently. The move was made in the interest of insuring the most efficient and economical operation of the mines as soon as steel market conditions warrant reopening them. **W. A. Blomstran**, present manager of the Port Henry District, will assume the duties of manager of the new district. Headquarters will be at the Port Henry mines in Mineville, N.Y. **W. G. Crusberg**, pres-



F. R. MILLIKEN



SHELDON JONES



H. J. SPEAR



W. ROTHERNHOEFER

ent manager of the Chateaugay District, will be transferred to the corporation's general offices in Cleveland, where he will undertake technical assignments relative to Republic's mining operations.

Sheldon Jones has been appointed assistant manager of the Huntington, W. Va. sales district of Goodman Mfg. Co. of Chicago. He was previously district manager for Hurlburt Oil & Grease Co., in its eastern division.

A recent announcement from Eastern Gas & Fuel Associates reported that **Walter Rothernhoefer**, vice president, retires the first of April but will be retained as a consultant to Eastern's coal sales organization. In anticipation of Mr. Rothernhoefer's retirement, **Harold J. Spear** was elected to succeed him, and at the same time was elected president and director of New England Coal & Coke Co., positions also relinquished by Mr. Rothernhoefer. Mr. Spear has been associated with the Eastern organization since 1919.

Personals

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Any recent activity that would be of interest to members:

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personals

continued

Jose A. Arguedas has moved to Lima, Peru, where he has taken a position as resident engineer for Utah Co. of the Americas, which is presently constructing an iron beneficiation plant for Marcona Mining Co. He was formerly employed as a project engineer by Western Knapp Engineering Co. in California.

Lawrence B. Wright, formerly chief of exploration for the land department of Southern Pacific Co., has resigned to resume a consulting practice as mining geologist with an office in San Francisco. He has recently been in charge of field work during a mineral survey of 14 million acres, 30 pct company owned. The survey, which included drilling out iron ores in Nevada after geophysical work, is nearly completed.

According to a recent announcement from The Colorado Fuel & Iron Corp., **Howard M. Dorward** has been appointed products sales engineer of Wire Rope Sales Dept., Western Div. He had been manager of Wire Rope Sales for the Rocky Mountain Div. since 1948.

Garry M. Sainsbury has taken a job as mining engineer with Broken Hill South Ltd., after serving as a surveyor with Consolidated Denison for six months.

John L. Holt, who had been serving as technical representative for Olin Mathieson Chemical Corp., explosives operations, has been transferred to the company's Chemical Div. as a mining engineer at Saltville, Va.

Following completion of his studies at the University of Oregon, **John S. Fryberger** has joined Robinson & Roberts, ground-water geologists. He is currently working on exploration to determine dewatering methods most feasible for use in constructing a three-mile long tunnel through glacial outwash.

Bruce B. Goddard was recently transferred from the Butte, Mont., operations of The Anaconda Co. to the Reno, Nev., Geological Exploration office.

Carl W. Westphal, consultant for Dorr-Oliver Inc., returned to South America at the beginning of the year to take charge of a 300 tpd pilot plant installed by Cia. Salitrera Anglo-Lautaro in the north of Chile. The investigation will cover the develop-

ment of a new process for the treatment of caliche fines.

John A. Engstrom has been named general manager of El Potosi Mining Co. and its subsidiaries, representing the Howe Sound Co.'s mining interests in Mexico. For the past nine years he had been unit manager for Cia. Minera de Penoles, S.A., a Mexican subsidiary of American Metal Climax Inc., at the Topia, Dgo., and Avalos, Zac. units.



J. A. ENGSTROM



F. V. SCHNEIDER

According to a recent announcement from WEMCO Div., Western Machinery Co., **F. V. Schneider** has been named to head a newly created Processing Equipment Dept. He was formerly field sales manager of the Division.

After six months as a trainee with Franklin Supply Co., **Gene F. Yoder** has been named assistant manager.

Anaconda Aluminum Co., Columbia Falls, Mont., recently announced the following changes in personnel:

Lars A. Ryssdal has resigned as potline superintendent to take a position as assistant to the manager of the Harvey Aluminum Inc. reduction plant in The Dallas, Ore. **Brown Lokken**, formerly potline engineer, was named to succeed Ryssdal. **Kenneth H. Fraser** was promoted to potline engineer from paste plant superintendent and **Lee W. Smith** has become paste plant superintendent. He had been working as a chemical engineer in the plant laboratory since joining the company in 1956.

After two years as resident manager for International Engineering Co., Mindanao, Surigao, Philippines, **William J. Rude** has returned to the U.S. where he is active in the coal industry. He is presently vice president, Hudson Coal Co.; vice president, Carbondale Coal Co.; and assistant to the president, Glen Alden Coal Co., Div. of Glen Alden Corp. He is serving as member of the Coal Research Board by appointment of Governor Lawrence of Pennsylvania. He recently opened a new strip mining operation in the so-called West Side Mine Fire area in the city limits of Carbondale, Pa., to prevent the spread of mine fire to other parts of the city.

W. A. Lyons has moved from Bolivia, where he had served as chief geologist of the Pulacayo, Animas, and Colquiri mines of Corporation Minera de Bolivia, to Peru, where

he is in charge of the geological department of Castrovirreyna Metal Mines Co.

Ralph C. Toerper has been appointed assistant director of research and development for the Langeloth, Pa. plant of Climax Molybdenum Co. In the past eight years, Mr. Toerper has advanced through the ranks from metallurgical engineer to plant manager of Climax Uranium Co., Grand Junction, Colo.



E. H. CRABTREE



R. C. TOERPER

According to a recent announcement from Mine & Smelter Supply Co., **E. H. Crabtree**, director of the Colorado School of Mines Foundation at Golden, has been elected to membership on the Board of Directors. For the first time in its 65-year history the company elected directors from outside the organization in an improvement move calculated to broaden the firm's knowledge and capabilities in the fields of research, new product development, and mining technology.

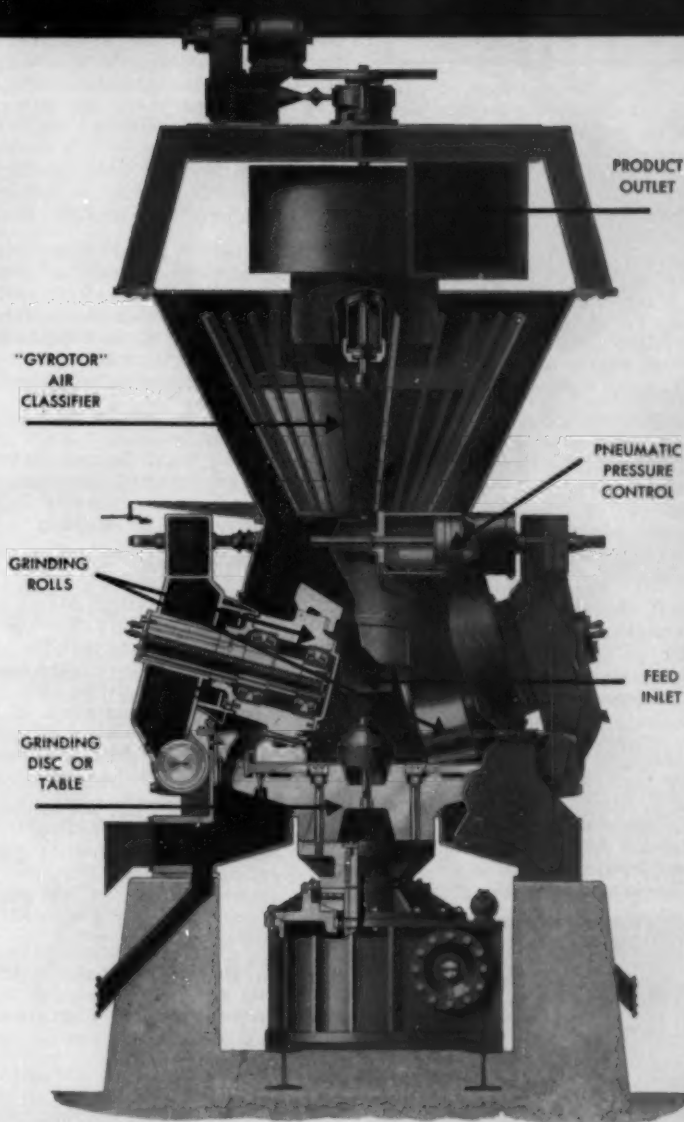
Eugene P. Pfeider, head of the School of Mines and Metallurgy, University of Minnesota, has been elected chairman of the Minnesota Section of AIME at the Section's annual meeting. Professor Pfeider has long been active in the affairs of the Institute, having previously been Chairman of Mining, Geology, and Geophysics of the national organization. Apart from his interest in mineral engineering education and mining research, he is an authority in the development of large-scale mining projects and currently a consultant for two of the large taconite developments in Minnesota and Labrador.

Adolph V. Mitterer has left International Minerals & Chemical Corp. to become manager of California Salt Co. of Los Angeles. The company, a wholly-owned subsidiary of Leslie Salt Co., mines rock salt by open pit methods from Bristol dry lake. In addition, it produces solar salt and calcium chloride as by-products.

Robert Bakish, director of research for Alloyd Corp., has been appointed vice president and member of the Board of Directors of Alloyd Electronics Corp.

Salih Faizi, who for 15 years was with McGraw-Hill Book Co. as assistant editor in crystallography, has joined the faculty of Curry College,

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personals

continued

Milton, Mass., as professor of geology. In his spare time he has been translating geological literature from the Russian for the American Geochemical Society.

D. R. Gibbons has been transferred to the Zurich, Switzerland, office of Arthur D. Little Inc. to bring the number of U.S. staff members to three. Their major function is to maintain the company's philosophy and standards in the steadily growing office, which is staffed chiefly by technically trained Europeans.

V. N. Antaki has joined J. C. Carlile Corp. of Denver as vice president of engineering. He will be associated with the engineering, design, and construction of chemical process plants and equipment. Mr. Antaki was formerly manager of Operations Dept. Services of Air Products Inc.

Derek C. Shelton, formerly mill superintendent for Camp Bird Colorado Inc. in Ouray, has become assistant metallurgist for Pima Mining Co., Tucson, Ariz. He had joined Camp Bird after returning from Mexico where he was assistant mill superintendent at ASARCO's Santa Barbara Unit. While at Camp Bird he was in charge of the design and construction of the new 500 tpd lead-zinc mill and the breaking-in of it. In his new job, Mr. Shelton is working on the problem of extracting a molyb-

denum concentrate from a primary rougher copper concentrate for which Pima recently completed a pilot plant.

After three years as a geologist with Homestake Mining Co., **H. A. Wollenberg, Jr.** has undertaken graduate work at the University of California. He has been working as a research assistant with the Radiation Laboratory and Department of Mineral Technology on a part-time basis. At present he is engaged on a project for the location of suitable low background material for use in construction of radiometric counting rooms.

Fred C. Wrobbe, former senior mining engineer for Aluminum Company of America working on its fluorspar operations, has been transferred recently to Alcoa Exploration Co.'s bauxite operation in the Dominican Republic as production superintendent.

Following his graduation from the University of North Dakota, **Robert M. Harris** has become sales engineer for Fischer & Porter (Canada) Ltd., with headquarters in Toronto.

Earl W. Donahue, works manager of the Phelps Dodge Refining Corp. refinery at El Paso, retired March 31, after more than 30 years of continuous employment at the plant. He and his wife will continue to make their home in El Paso, where he may engage in some consulting work. **M. S. Bell**, who had been assistant works manager, has been named to succeed Mr. Donahue.

After graduation from the University of Wisconsin in June of last year, **John W. Nichols** went to work for Kennecott Copper Corp. as a management trainee at Bingham mine. He was recently promoted to second designer.

John C. Osmond, Salt Lake City consulting petroleum geologist, was elected president of the Utah Geological Society early this year.

J. Frank Henderson, who had been a metallurgical engineer in the Development Dept. of Kaiser Engineers, has joined Texas Gulf Sulphur Co. as plant superintendent. He is now engaged in designing a new potash facility at Moab, Utah.

H. G. Grant has joined Canadian Refractories Ltd. in Kilmar, Que., as mine engineer for Copper Rand Chibougamau Mines Ltd.

According to a recent announcement from Phelps Dodge Copper Products Corp., **Alfred F. Van Ranst** has been elected vice president of its Inca Manufacturing Div. Since 1956, he has been the sales manager of this magnet wire division and will be in charge of the sales of this division.

William C. Peters, who had served as geologist for the past seven years

with the Mineral Development Dept. of Food Machinery & Chemical Corp., has become division geologist of Utah Copper Div., Kennecott Copper Corp. His present duties include heading the geology department of the Utah Copper Mine at Bingham Canyon.



J. J. BIRDCCELL



ERWIN GAMMETER

John J. Birdcell, formerly technical administrator, P. R. Mallory & Co., Indianapolis, has been named coordinating engineer of the Copper Products Development Assn., New York City. In his new position, Mr. Birdcell will assist **Charles H. Moore**, technical director of the Assn., in monitoring research projects aimed to develop new and improved uses for copper.

Erwin Gammeter, a vice president with Paul Weir Co. Inc., has returned after serving 27 months as head of the firm's coal mining mission in South Korea. The team formed the mining portion of a joint industrial group supplying technical assistance to the government of the Republic of Korea. Mr. Gammeter previously served as project manager on a coal mine development program in Turkey, and as chief of party for experimental coal mining in Brazil.

The Copper Range Co. recently announced the appointment of **Richard C. Cole** of Salt Lake City, as executive vice president and general manager of White Pine Copper Co., a wholly-owned subsidiary of Copper Range. For the past two years Mr. Cole has been vice president of manufacturing for Vitro Chemical Co. and vice president of Vitro Minerals Corp.; prior to that he was president and general manager of Vitro Uranium Co.

Ivon A. Bailey, chairman and chief officer of The International Nickel Co. (Mond) Ltd., of the United Kingdom, has been elected a vice president of The International Nickel Co. of Canada Ltd., its parent company, and **John O. Hitchcock**, managing director and second chief officer of the United Kingdom subsidiary, has been elected an assistant vice president of the parent company.

G. R. Fisher, chairman of Mount Isa Mines Ltd., recently announced that **A. M. C. Buttfeld** has joined the Board of directors. Mr. Buttfeld recently retired as general manager of The Australian Mutual Provident Society.



Mrs. and Mr. Norman Weiss, American Smelting & Refining Co., John Cheavens, front left, Western Knapp Engineering Co., and E. H. Scheick, front right, American Smelting & Refining Co. embark for Australia to confer with technical and management men of Mt. Isa Mines Ltd., about design-engineering coordination on the major expansion of Australia's largest complex of mines, mills, and smelters.



J. H. HAYNER



ARTHUR GLOSTER

Joseph H. Hayner was recently appointed director of technical planning of the Patterson Moos Research Div. of Leeson Corp. Prior to joining Patterson Moos, Mr. Hayner was associated with The Anaconda Co., where he acted as advisor on nuclear energy technology.

According to a recent announcement from Texas Gulf Sulphur Co., **Arthur Gloster** has joined the company as assistant manager of research. He was formerly chief engineer for Titlestad Corp., specializing in the design of sulfuric acid plants.

After two years as general superintendent of operations for Braden Copper Co. at Rancagua, Chile, **R. C.**

Bylaws

(Continued from page 498)

sion or by the Society Nominating Committee as the case may be.

The officers of the Planning Committee shall consist of a Chairman, First Vice-Chairman, Second Vice-Chairman, and a Secretary, all for a term of one year, and shall be elected from and by the members of the Planning Committee.

All tenures shall terminate at the time of the annual meeting of the Society.

The planning Committee shall have the duty and responsibility of long-range planning for the advancement of the Society towards realization of the aims and objectives stated in Article I, Section 2. Their capacity shall be that of an advisory body to the President and Board of Directors. The authority of the Planning Committee shall be limited to the preparation of recommendations to the President and the Board, but they shall be given all reasonable help and cooperation in securing information from the Society and all of its parts for the performance of their duties.

The President, Past President, President-elect, and Secretary of the Society shall be unofficial members of the Planning Committee during their terms of office, without vote."

The SME Board has directed that its members will vote on the acceptance or rejection of the proposal at its next meeting. A majority of the votes cast will be necessary for its adoption.

Bacon has moved to Santiago to become manager of operations for Cia. Minera Santa Fe, the largest iron ore producer in Chile.

John H. Klas, former executive director, Utah Petroleum Council, has been appointed director of public relations for the Utah Copper Div. of Kennecott Copper Corp.

Donald C. Smith has moved to Conda, Idaho to take a position as mine engineer with J. R. Simplot Co. He was formerly a project engineer with Utah Construction & Mining Co.

J. G. L. Wardrop, formerly an engineer with Bakely Steel Ltd. in Ghana, has partially retired to a small estate in Scotland, where with his son he is building up a commercial poultry farm.

James H. Bright, formerly a geologist with Union Carbide Nuclear Co., has taken a position as district geologist for Asbestos Corp. Ltd.

J. N. Cooksey, Jr. has moved to Winnfield, La., to work as assistant plant engineer for Carey Salt Co. He was formerly staff engineer, mining Engineering Dept., Peabody Coal Co.

Dean W. Baseley has accepted a position as industrial engineer with Old Ben Coal Corp. He had formerly been with Crucible Steel Co. of America.

J. K. Brooke, formerly administrative mining engineer, Kaiser Aluminum, and **R. M. Dreyer**, formerly assistant chief geologist, Reynolds Metals and chief geologist, Kaiser Aluminum, announce the formation of a consulting practice in mining engineering, mining geology, and mining geophysics with offices at 465 California St., San Francisco.

James R. Perrin, Jr., formerly shift boss for Hidden Splendor Mining Co., at Grants, N. M., has moved to Tulsa to work as an engineer for Fennix & Scisson Construction Co.

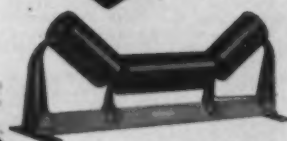
After seven years as works manager for Erie Mining Co., Pickands Mather Co., **L. E. Johnston**, has been made general manager of Wabush Iron Co. Ltd., in Montreal.

Quintin M. Cohenour has moved to Whittier, Calif., to take a position as assistant general plant superintendent for Western Lead Products Co. He had worked as a metallurgist for American Smelting & Refining Co., in Leadville, Colo. for the past eight years.

Upon his return from Venezuela where he was employed by the Orinoco Mining Co., **Richard Walssar** has gone to work as a mining engineer for Lance Corp., Grants, N. M.



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SME PREPRINTS AVAILABLE — 1961 Annual Meeting, St. Louis

The following list of papers (from the 1961 St. Louis Annual Meeting) will be available until January 1962. Coupons (blue) received with the 1961 Dues Bills and those distributed at the Annual Meeting will be honored until Dec. 31, 1961. Purchased coupon books (yellow) will be honored at any time. As more preprints become available they will be added to this list and bulleted (•).

Preprints may be obtained (upon presentation of properly filled out coupons) from Preprints, SME Headquarters, 29 W. 39th St., New York 18, N. Y. Additional coupon books can be obtained from SME for \$5 (book of ten) to members or \$10 (book of ten) to nonmembers. Each coupon entitles purchaser to one paper. Please do not use coupons for papers other than those listed by number.

COAL (F)

- Bowman, E. V., and Hurst, E. J.: Material Handling Aspects of Fine Coal Cleaning, 61F08.
- Boyle, J. A., and Conn, O. S.: Control of Mine Ventilation Utilizing Multiple Main Fans, 61F40.
- Elliott, M. A.: Coal Gasification for Production of Synthesis and Pipeline Gas, 61F61.
- Hamilton, G. M.: Gasification of Solid Fuels in the Wellmann-Galusha Gas Producer, 61F8.
- Hightower, T. R., and Mellor, M. W.: Thunderbird Collieries, 61F64.
- Jamison, R. H., Jr.: Full Dimension Systems, 61F36.
- MacDonald, J. W.: Coal Preparation Plant Facilities, Old Ben Mine No. 21, Sesser, Franklin County, Illinois, 61F00.
- Macpherson, H.: Froth Flotation in Durham Division of National Coal Board, 61F45.
- Miller, J. W.: Economic Justification for Froth Flotation, 61F06.
- Mongan, C. E., Jr., and Miller, T. C.: Use of Sonic Techniques in Exploring Coal-Mine Roof Strata, 61F33.
- Oppelt, W. H., and Kube, W. R.: Bench-Scale Experiments on Low-Temperature Carbonization of Lignite and Subbituminous Coal at Elevated Temperatures, 61F1.
- Oppelt, W. H., and Gronhoyd, G. H.: Design and Preliminary Operation of a Slagging Fixed-Bed Pressure Gasification Pilot Plant, 61F18.
- Orlandi, W. J.: Requirements and Advantages of an All-Belt Mine Haulage System, 61F9.
- Parisi, C. W.: Use of High Expansion Foam on an Actual Mine Fire, 61F70.
- Peters, J. T., and Shapiro, N.: Know Your Coal, 61F02.
- Risser, H. E.: Adaptability of Illinois Coal for Use in Iron and Steel Production, 61F50.
- Sallmann, K.: German Coal Flotation—1960, 61F06.
- Valeri, M.: Continuous Mining in the Pittsburgh Seam, 61F46.
- Washburn, H. L., and McConnell, W. A.: Design of Loveridge Plant, 61F58.
- Welmer, W. A.: Peabody Coal Company's "River King Mine," 61F30.
- Wotring, R. W.: Lee-Norse Miner in the No. 4 Pocahontas Seam, 61F63.
- Wright, F. D.: Maximizing the Profit of a Coal Preparation Plant by Linear Programming, 61F16.

ECONOMICS (K)

- Douglas, T. B.: Economics of 5½ Mile Transport Conveyor Belt at Ideal Cement Company's Ada, Oklahoma, Plant, 61HK28.
- Dubnie, A.: Transportation of Minerals in Northern Canada, 61K11.
- Elsemann, E. F., Jr.: Some Aspects of Competition Between Fuels in the United States, 61K80.
- Gritzuk, N.: Long Haul Transportation of Minerals in Canada's Far North West, 61HK34.
- Jaworek, W. G., and Schanz, J. J., Jr.: Fuel Interchangeability—Measuring Its Extent in U.S. Energy Markets, 61K43.
- Lasky, S. G.: Mineral Self-Sufficiency, 61K4.
- Lentz, O. H.: The Depletion Rationale and Recent Political Pressures of Erosion, 61K91.
- Quinn, F. J.: Natural Gas and the Competitive Fuel Market, 61K90.
- Riggs, W. A.: Transportation Economics of Mineral Commodities, 61HK19.
- Robinson, M. E., and Kurtz, W. L.: Competitive Markets—The Fossil Fuels, 61K23.
- Roetzer, A. A.: Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry, 61HK50.
- Wilhelm, O., Jr.: Water Transportation of Fertilizer Raw Materials, 61HK75.
- Young, R. A.: The Quota System in Mining—Particularly Lead and Zinc, 61K96.

EDUCATION (J)

- Forrester, J. D.: The Future for Educational Training of Mineral Industry Engineers, 61J08.
- Just, E.: Preparing Men for Mining's Future, 61J97.
- Knoerr, A. W.: What the Mining Industry Expects of Mining and Mineral Processing Engineers, 61J108.

- Reed, J. J.: The Interdependence of Mining Education, Research, and the Industry, 61J99.

GEOLOGY (I)

- Baker, A., III, and Scott, B. C.: Geology at the Pitch Mine, 61I53.
- Blair, R. A., and Stubbins, J. B.: The Role of Mining Geology in the Exploitation of the Iron Deposits of the Knob Lake Range, Canada, 61I101.
- Freeze, A. C.: Use of Punch Card Accounting Machines in Calculating Reserves at Sault Ste. Marie Mine, 61I85.
- Perry, V. D.: The Significance of Mineralized Breccia Pipes, (Jackling Lecture) 61I78.
- Shea, E. P.: The Use of Geology in Butte, 61I29.

GEOPHYSICS (L)

- Fahnestock, C. R.: Use of Seismic Techniques in Analyzing Subsurface Materials, 61L45.
- Heyburn, M.: Geologic Mapping with the Aid of Magnetism, Tahavus Area, New York, 61L13.
- Meech, A. F., and Riley, L. B.: Basic Statistical Measures Used in Geochemical Investigations of Colorado Plateau Uranium Deposits, 61L37.
- Whitten, E. H. T.: Quantitative Distribution of Major and Trace Components in Rock Masses, 61L17.

INDUSTRIAL MINERALS (H)

- Barnes, R.: Perlite—A Review, 61H83.
- Barr, H. W., Jr.: Problems in Gaging Markets for Specialty Fillers, 61H100.
- Blair, L. R.: Synthesis of Inorganic Silicate Fillers and Filter Aids, 61H76.
- Blumeister, W. C.: Rock Salt Mining and Economics in the North Central Area, 61H92.
- Czel, L. J., and O'Brien, W. F.: Lithium Horizons, 61H60.
- Dole, H. M., Jr.: Mining vs Public Land Withdrawals, 61H35.
- Douglas, T. B.: Economics of 5½ Mile Transport Conveyor Belt at Ideal Cement Company's Ada, Oklahoma, Plant, 61HK28.
- Goldman, H. B.: Urbanization and the Mineral Industry, 61H24.
- Gray, J. E.: Specifications for Mineral Aggregates, 61H82.
- Golson, C. E., and Newton, D. E.: Application of Metallurgical Principles, Processes, and Equipment to the Production of Mineral Aggregates, 61H87.
- Gritzuk, N.: Long Haul Transportation of Minerals in Canada's Far North West, 61HK34.
- Herfindahl, O. C.: Conflicts Between Mining and Other Economic Activities—A General View, 61H74.
- Jackson, T. M., and Jones, R. K.: The Role of Organic and Inorganic Fibers in Gaseous and Liquid Filtration, 61H79.
- Klenitz, L.: Better Aggregate Processing Pays Off, 61H44.
- Landes, K. K.: Chemical and Metallurgical Limestone in North Central, Northeastern States, and Ontario, 61H41.
- Lemish, J.: Research in Carbonate Aggregate Reactions in Concrete, 61H93.
- Maddock, T. J., Jr.: Quarrying or Mining Versus Water Reservoirs, 61H31.
- Mussey, O. D.: Water: Its Role in Mining and Beneficiating Iron Ore, 61H81.
- Price, W. L.: Wire Cloth and Perforated Plate for Vibrating Screens (NSGA Circular #80), 61H71.
- Riggs, W. A.: Transportation Economics of Mineral Commodities, 61HK19.
- Roetzer, A. A.: Materials Handling, Transportation, and What Lies Ahead in Packaging in the Cement Industry, 61HK50.
- Wilhelm, O., Jr.: Water Transportation of Fertilizer Raw Materials, 61HK75.
- Williams, V. C.: Saline Water Conversion Economics, 61H36.
- Wollman, N.: Our Future Water Needs—PMPC Forecast vs RFF Estimate, 61H32.

MINERALS BENEFICIATION (B)

- Bailey, C. N.: Economic Factors Affecting Design of a Milling Plant, 61B88.
- Bergstrom, B. H., and Sollenberger, C. L.: Kinetic Energy Effect in Single Particle Crushing, 61B94.

- Bond, F. C.: Principles of Progeny in Comminution, 61B15.
- Bowditch, F. W.: Theoretical and Experimental Studies of the Kinetics of Grinding in a Ball Mill, 61B25.
- Brown, W. N.: Innovations in Large Volume Warehousing and Handling of Bulk Materials, 61B72.
- Browning, J. S.: Flotation of North Carolina Spodumene-Beryl Ores, 61B20.
- Curtis, C. H.: The Esperanza Concentrator, 61B77.
- Dar, A.: Recent Trends in Iron Ore Beneficiation and Their Effect on Mill Design and Layout, 61B54.
- Dresher, W. H.: A Mechanism Study of the Formation of Sodium Vanadate Compounds Under the Conditions of the Salt-Roast Process, 61B48.
- Gaudin, A. M., and Fuerstenau, M. C.: Determination of Particle Size Distribution by X-Ray Absorption, 61B3.
- Heifrich, W. J., and Sollenberger, C. L.: Relative Reduction Rates of Porous Iron Oxide Pellets, 61B52.
- Hoffman, I., and Marbacher, B. C.: Beneficiation of Israeli Phosphate Ore, 61B57.
- Howell, F., and Stoehr, R. J.: Handling and Drying of Wet Ambrosia Lake Ores, 61B93.
- Larsen, E. P.: Blending and Handling of Materials for Agglomeration, 61B22.
- Lash, L. D., and Ross, J. R.: Scandium Recovery from Vitro Uranium Solutions, 61B51.
- Levine, N. M., and Fassel, W. M.: The Technique of Gas Oxidation During Pulp Agitation, 61B10.
- Li, K. C.: Chemical Processing of Tungsten Ores and Concentrates, 61B7.
- Peirce, J. W.: Mass Flow Measurement of Mine Slurries, 61B86.
- Raring, R. H., and Murray, G. Y.: Effect of Mining Operation and Tailings Disposal Requirements on Mill Design, 61B30.
- Sather, N. J.: Concentrator Operation at the Bunker Hill Company, 61B5.
- Speers, E. C., and Woodruff, F. G.: Materials Handling Facilities at the Ray Mines Division Expansion Program, 61B14.
- Sudbury, M. P., and Petkovich, Y.: Exothermic Hardening of Copper-Nickel Sulfide Agglomerates, 61B40.
- Takahashi, Y., Serizawa, M., Miyagawa, K., and Shimomura, Y.: New Process in Sintering of Fine Iron Ores, 61B6.
- Thompson, C. D.; Czako, C. A.; and Violetta, D. C.: Beneficiation of Cement Raw Materials by Dwight-Lloyd Processes, 61B12.

MINING (A)

- 61A102—One Preprint Covering:
- Just, E., and Parks, G.: Research in Mining, 61A102A.
- Carpenter, R. H.: Research in Exploration, 61A102B.
- Bates, C.: Underground Nuclear Testing Detection, VELA UNIFORM, and Mineral Technology, 61A102C.
- Lyon, R. J. P., and Westphal, W. H.: Future Trends in Mining and Exploration, 61A102D.

OPEN PIT MINING (AO)

- Lackey, V. D.: The 'Lectra Haul' Truck and Its Use on the Mesabi, 61AO23.
- Pfeider, E. P., and Dufresne, C.: Transporting Open Pit Production by the Truck-Ore Pass-Adit System, 61AO56.
- Stewart, R. M., and MacQueen, C. W.: The Electric Wheel Truck in Anaconda's Operations, 61AO84.
- Vickers, E. L.: Application of Marginal Analysis in the Determination of Cut-Off Grade, The 61AO21.

UNDERGROUND MINING (AU)

- Lang, T. A.: Theory and Practice of Rock Bolting, 61AU35.
- Morlan, E. A.: Boring Large Hole Mine Openings, 61AU27.
- Panek, L. A.: Measurement of Rock Pressure with a Hydraulic Cell, 61AU41.
- Ryon, J. L., Jr.: Underground Use of Ammonium Nitrate-Fuel Oil Explosives, 61AU25.
- Waples, B. R., Jr.: Altmak Raise Climber at Iron King Branch of Shattuck Denn Mining Corporation, 61AU26.

• Indicates Preprints not available in St. Louis, or those papers received at the Preprint Center after the meeting was in progress.

Obituaries

George W. Potter

An Appreciation by
R. K. Stroup

George W. Potter, Sr., (Member 1917), prominent and colorful figure in the Tri-State Mining Area and former executive of the Eagle-Picher Co., died in St. Johns Hospital, Joplin, Mo., Thursday evening Feb. 16, 1961. He was 69 years old. He had been in ill health for several months, but was admitted to the hospital only the day before his death.

Mr. Potter was born in Galena, Kan., Jan. 27, 1892, and moved with his parents to Joplin in 1902, where he had since resided. He studied civil engineering at the University of Missouri, and worked on railway and drainage projects in the Southwest.

He joined the Eagle-Picher Co. in 1915 at the time of their discoveries in the Picher area and soon became local manager of their fast-developing operations. In 1930 he was named vice president of their mining and smelting division and later, executive vice president. He resigned in

1944 to conduct a private business of his own.

He acquired the Ortez Grant, a 62,000 acre tract of mineral lands near Santa Fe, N. M., and formed a partnership with Dewey Sims of Miami, Okla., to develop and mine this property. This work is still in progress. The Potter-Sims Co. also operated several mines and mills in the Tri-State District during the period 1950 to 1960.

No man has left a greater impression on the Tri-State District than George Potter. As local manager for Eagle-Picher when the area was seething with activity—hundreds of exploratory drills at work—new shafts being started every day—mills springing up almost over night—he played an important part in the activities.

In the early years of the depression when all the mines were shut down and the mills rotting away, many predicted that the field was finished, but not George Potter. He saw that the old mills would have to be replaced by a larger, more modern concentrator supplied by more flexible mining units. Ores would be transported on the surface by train and truck, and an elaborate system of sampling and accounting were provided for.

Mr. Potter was able to sell this idea to the board of directors and in

March 1932 started construction of a central mill-transportation system and rehabilitation of the mines. In later years this plant reached a production of 14,000 tpd and was a major factor in enabling Tri-State to meet the heavy demands made by World War II.

Phillip C. Emrath

An Appreciation by
William H. Roll

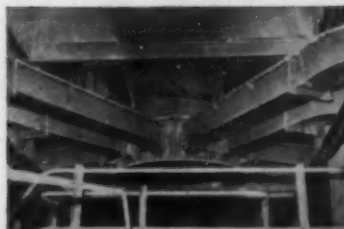
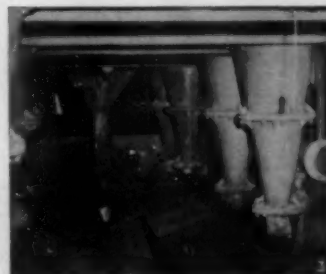
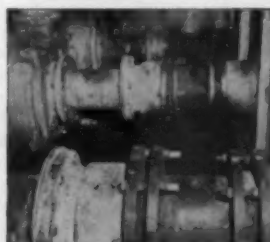
Phillip Cassily Emrath (Member 1948) died July 4, 1960, at his home in Lexington, Ky. He was born New Year's Day, January 1, 1900, at Bellevue, Ky. His death was a blow to the mining industry, and to those who knew him more intimately, his passing was the loss of a good friend. His cheerfulness, sympathetic understanding, and an ever-present sharp and subtle humor were qualities which his associates valued.

His early life was spent in St. Louis and Chicago. I have also heard him speak of living on Walnut Hall farm in this vicinity.

After getting his degree in mining engineering, Phil went to work for the American Zinc Co., Mascot, Tenn. He started as a miner and was subsequently promoted to mining en-

(Continued on page 518)

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2. View of Linatex-lined distribution box and chutes.
3. View of cyclone underflow and discharge hopper.

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Obituaries

(Continued from page 517)

gineer, and then to superintendent of mining. There followed 14 years as associate professor of mining in the College of Engineering, University of Kentucky. An outstanding part of the work at the University, in addition to teaching, was the revision and expansion of the mining engineering curriculum for approval of Engineering Council in College Accrediting program 1935, 1936, and 1937. From 1943 to 1951, he managed fluorspar and lead oxide mining operations in the western Kentucky and Illinois area. Then came three years in Taipai, Formosa as senior engineer for the J. G. White Co. of New York City. Upon the completion of this assignment, Phil went to Indonesia with a team of University of Kentucky staff members to assist in setting up a college of engineering at Bandung. After three years in Indonesia he returned to Lexington, Ky. in the capacity of a private consultant. His jobs were varied and covered a wide area of the U.S. and Mexico.

John Tyssowski (Legion of Honor Member 1910) died Nov. 24, 1960, at the age of 73. He was born in Washington, D. C., and spent much of his life in and near the city. While still a student of the College of Mines, University of California, he gained his first professional experience working one summer as sampler and engineer's assistant for Montana Tonopah Mining Co. Following his graduation he went to work as field

boss for Columbia Granite & Dredging Co. Early in 1909 he became a member of the editorial staff of *The Engineering and Mining Journal*, New York City. During World War I he served in the Quartermaster Corps, rising to the rank of major. In recent years he was chairman of the board of Woodward & Lothrop, Washington, D. C., and at the time of his death, chairman of the executive committee.

Ernest Burchard (Legion of Honor Member 1909) was killed in a fire which swept the Mount Vernon Nursing Home in Washington D. C., Feb. 1, 1961. He was internationally known as a mining geologist who had worked with USGS for over 40 years before his retirement in 1945. During both World Wars he was called upon for special service. In World War I he organized Geological Survey studies of ferro-alloy metals. In World War II he organized and directed emergency efforts to expand the country's reserves of bauxite for the production of aluminum. Mr. Burchard was born May 20, 1875, in Independence, Kan. He was a graduate of Northwestern University and later received his M.S. degree in geology there. During his years with USGS he became known for his field work on iron ores and structural materials in all parts of the U.S. His work abroad included studies of the chrome and manganese ores of Cuba, the petroleum fields of the Philippines and Argentina, and the iron and manganese ore fields of Brazil and Venezuela.

Louis Garbrecht (Member 1941) died Feb. 12, 1961 in an El Paso hospital following a short illness. He had been a resident of El Paso for more than 30 years. He was born in Seguin, Texas, Oct. 10, 1886 and received his education at the University of Texas. Mr. Garbrecht was active as a mining engineer and geologist for 50 years. He was engaged as an independent consultant in the U.S., Mexico, and Central America. Early in his career he was on the staff of Spurr & Co. and Tonopah Mining as scout and field engineer on mine examinations; as superintendent of Nicaraguan subsidiaries of Tonopah Mining; and as superintendent of a number of Tonopah mines in Canada. Other companies with which he was associated over the years were: Cia. Minera Real del Monte S.A., Cia. Minera de San Rafael, and San Francisco del Oro Mines, all of these companies were in Mexico. He also did work for AEC in Brazil and Grand Junction, Colo.

Cyril W. Knight (Legion of Honor Member 1907) died Oct. 13, 1960, after a long illness, just a little more than a month before his 81st birthday. Mr. Knight was a Canadian and was a graduate of Queen's University, Kingston, Ont. He later took

post graduate work in geology and metallurgy at Columbia University. After leaving Columbia, Mr. Knight went to work for the Bureau of Mines, Toronto, as assistant geologist. In recent years he had carried on a practice as consulting geologist in Toronto until his retirement in the late 1950's.

Alex Leggat (Legion of Honor Member 1902), 85, and for 81 years a resident of Butte, Mont., died the early part of January of this year. He was well known as both a mining engineer and hotel owner and at the time of his death was residing in the Leggat hotel which he had owned and operated since it was built in 1914. Mr. Leggat was born in Owosso, Mich., and moved to Butte early in 1880 when his mother joined her husband who was operating a mine and mill at Dewey. He attended the College of Montana at Deer Lodge, received his B.S. degree from Houghton School of Mines, and later attended the University of Utah and Columbia University where he did post graduate work.

Throughout his lifetime, Mr. Leggat gathered together perhaps the greatest collection of historical books, documents, manuscripts, individual letters, Vigilante records, and interesting relics connected with the growth of the state. His historical records also reviewed Butte's past from a mining camp to a metropolitan city.

He was past-chairman of the Montana Section of AIME and the Montana Society of Engineers. He was also a member of the Northwest Mining Assn.

William P. Putnam (Member 1918) died at the age of 90, Jan. 26, 1961. He was founder of the Detroit Testing Laboratory Inc. in 1903 and retired as its president in 1948. Mr. Putnam was born in Belpre, Ohio; took his B.S. degree at the University of Akron (then Buchtel College); and later attended the Case School of Applied Science, Cleveland taking graduate work in chemistry and metallurgy. Before founding the Detroit Testing Laboratory, he held chemist positions with Corrigan & McKinney Co., Pittsburgh Iron & Steel Co., Superior Iron Co., and others. During World War I he served as chief chemist in U.S. Army Ordnance. He was also a member of many professional societies and assisted in organizing the Detroit Section of AIME.

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Volume 217, 1960

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Necrology

Note: The listing of Quincy A. Shaw, Jr. in the March 1961 issue of *MINING ENGINEERING*, page 309 was in error. The listing should have read:

Date Elected	Name
1923	Quincy A. Shaw

Date of Death
May 8, 1960

Date Elected	Name	Date of Death
1901	Thomas Cox	March 14, 1961
1955	Lloyd E. Dueme	March 3, 1961
1906	R. W. Gordon	Unknown
1956	W. W. Heilman	Feb. 14, 1961
1941	James C. Johnston	Unknown
1927	Easper S. Larsen	March 8, 1961
1924	Charles H. Matthews	Dec. 11, 1960
1951	Edward LeMaire	February 1961
1897	Fred H. Minard	Unknown
	(Legion of Honor)	
1914	Miles S. Milward	Unknown
1917	George W. Potter	Feb. 16, 1961
1940	G. R. Spindler	Feb. 20, 1961
1957	Ronald L. Terrill	Unknown
1946	P. W. Kruse	Feb. 20, 1961

Membership

Proposed for Membership

Society of Mining Engineers of AIME

Total AIME membership on March 31, 1961, was 35,200; in addition 2,145 Student Members were enrolled.

ADMISSIONS COMMITTEE

S. S. Cole, Chairman; F. A. Ayer; F. Wm. Blocher; H. L. Brunjes; I. A. Given; R. T. Lassiter; R. J. Middlekauff; L. T. Warriner; G. W. Wunder.

The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

Members

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Leif E. Arentzen, Arvada, Colo.

William E. Austin, St. Louis
George C. Breidenbach, Belleville, Ill.
Anthony P. Cerkel, Santa Cruz, Philippines
Edmond E. Chastus, New York City
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George F. Crocker, Wawa, Ont., Canada
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